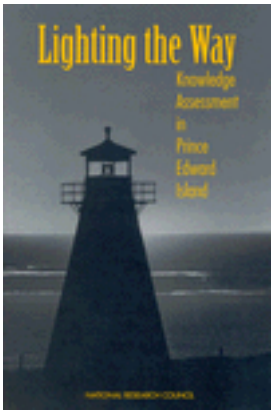

Lighting the Way: Knowledge Assessment in Prince Edward Island

Committee on Knowledge Assessment, National Research Council

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Lighting the Way

Knowledge Assessment in Prince Edward Island

Committee on Knowledge Assessment
Office of International Affairs
National Research Council

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competence and with regard for appropriate balance.

This report was prepared by the Committee on Knowledge Assessment. Support for the project and for this report came from the Knowledge Economy Partnership of Prince Edward Island, Canada. The report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the organizations or agencies that provided support for the project.

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Note from the Chairman

This report represents the first experience with National Knowledge Assessment, a method developed in 1996 by a committee of the National Research Council at the request of the World Bank. It is intended to explore a country's potential for adopting and using technology to find a niche in the global marketplace. It was designed for developing countries, and has as its model the small number of countries in Asia and Latin America that, until recently, have lifted themselves from the ranks of the have-nots by employing knowledge and creating knowledge-based enterprises. The problems that many of them have encountered in past months in no way diminishes the role that knowledge will continue to play in the world economy.

The method itself, called knowledge assessment after a remark of World Bank vice president Jean-François Rischard, is an unusual one, both for the Bank and the NRC. Instead of gathering facts by the concentrated efforts of economists and other scholars and drawing conclusions from them in well-appointed conference rooms, the effort is taken into the field, and the inputs come from the country's stakeholders, the businessmen and women, scientists, engineers, and producers who know very well what their problems are and where their systems fall short. The knowledge assessment provides a forum for them, a role-playing exercise that allows them to find solutions for themselves through strategic questioning by a handful of foreign experts in business and technology.

It was recognized by the committee at the outset that such an unusual procedure as this one required a pilot project trial before the National Research Council and its authors would comfortably stand behind it as a useful tool for development planning. For this reason the NRC publication is called *Prospectus for Na-*

tional Knowledge Assessment, the word prospectus conveying our lack of certainty and commitment. We set about to find a country willing to collaborate with us in the first trial, but before we succeeded, technology itself intervened. A consultant to the Institute of Island Studies in Prince Edward Island found an account of the method on the World-wide Web and set in motion the train of events that led to the present report.

Prince Edward Island was not our original idea of a test site. For one thing it is not a developing country, nor for that matter even a country. It is the smallest province of Canada, our quite highly developed neighbor. But some of its problems are exactly the sort that the knowledge assessment method was designed to explore—stagnant primary sectors, brain drain, and economy dependent on transfers from away. Further, it promised a highly exacting and demanding test. The participants in the working meetings would be as sophisticated and qualified as any we were expecting to encounter in the Third World. The process was taken extremely seriously; the costs were borne by a consortium of government, private sector, and university, all of whom had practical, but not coinciding, interest in the findings and recommendations. And lastly, there was no international development bank waiting in the wings to shower everyone with projects to correct the weaknesses identified. If PEI takes action to implement some of our recommendations, it will be with their own money, and that, we are sure, will evoke the most demanding critical and well-considered judgments.

We offer our thanks to the Institute of Island Studies of the University of Prince Edward Island, to the Provincial Government, and to all those who worked with our teams to produce this report. Our NRC volunteer experts have enjoyed the experience, and we believe that the PEI participants have also found it productive. Further evidence is the apparent emergence of embryonic enterprises as a direct result of some of the activities. We have learned a great deal about our method, and I feel that knowledge assessment is now in a position to be applied in other appropriate venues with diverse development status and needs. We have also learned much about Prince Edward Island, and the collaboration has been a pleasure.

Acknowledgment

The Committee is grateful to the many individuals who made substantive and productive contributions to this project. Particular thanks are due to the colleagues at the Institute of Island Studies whose commitment to this project was firm and infectious. Special praise is due to the leadership and historical perspective contributed by Harry Baglole, the logistical genius of Nancy Murphy, and editing skills of Ed MacDonald. Special mention must be reserved for Wendy MacDonald, whose research contributions and perceptive advice on key issues were invaluable to the knowledge assessment team. We would also like to thank Verna Bruce for her initial interest and support for the notion of doing a knowledge assessment in Prince Edward Island, and Gary Stairs for finding us on the World-wide Web and setting the whole enterprise in motion. Finally, the committee would like to thank all the participants in the focus groups and the virtual case studies for playing their roles in a most convincing manner and providing most of the knowledge that went into this report.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress and signed by Abraham Lincoln in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

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The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

The Office of International Affairs (OIA) is concerned with the development of international and national policies to promote more effective application of science and technology to economic and social problems facing both industrialized and developing countries. OIA participates in international cooperative activities, engages in joint studies and projects with counterpart organizations, manages scientific exchange programs, and represents the Academy complex at many national and international meetings directed toward facilitating international cooperation in science and engineering. Dr. F. Sherwood Rowland, Dr. Harold Forsen, and Dr. David Challoner are the foreign secretaries of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, respectively.

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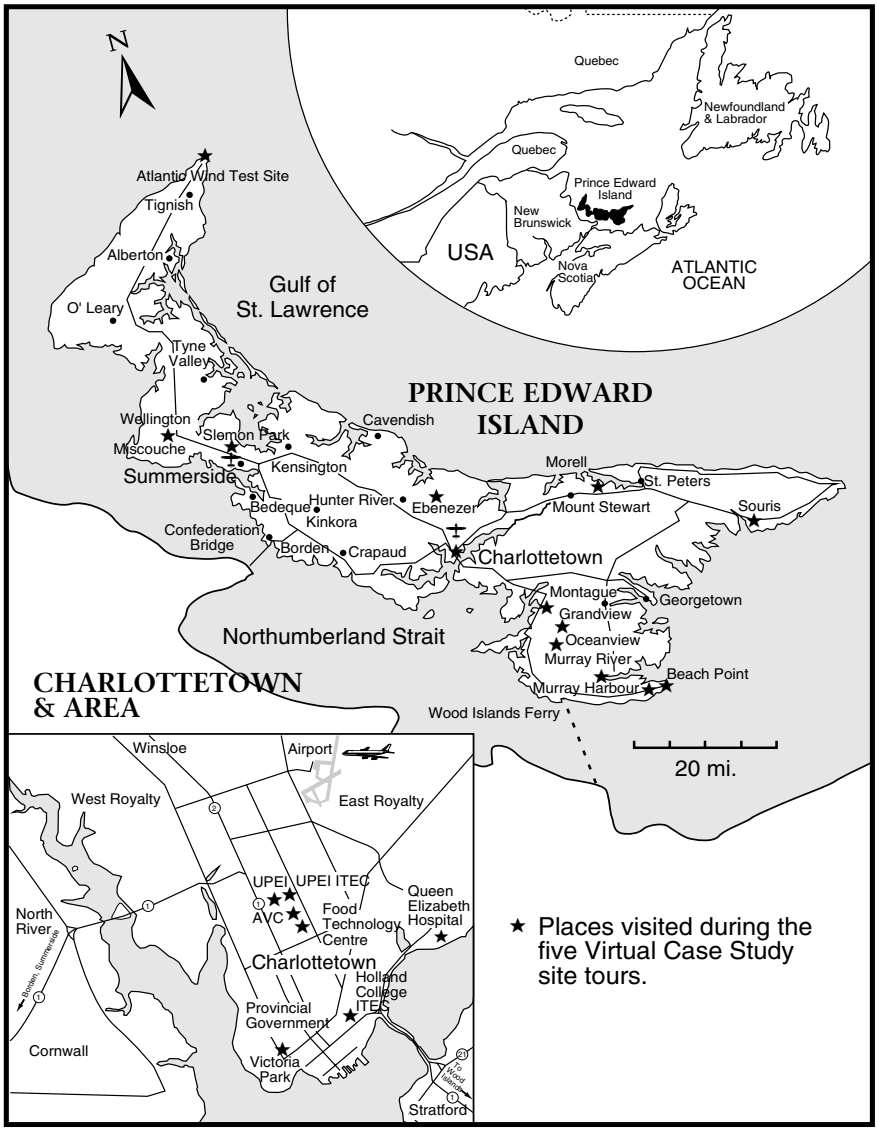

Map design by Audio Visual Services, University of Prince Edward Island

Executive Summary

Knowledge Assessment is a methodology to evaluate a community's ability to acquire, diffuse, and utilize knowledge created by the National Research Council at the request of the World Bank. It was conceived to assist developing countries or other jurisdictions to cultivate knowledge-based enterprises capable of generating wealth from knowledge and technology. Designed to be rapid and low cost, it relies on a role-playing venture capital model whereby a small number of visiting experts work with local producers, researchers, and others to explore the local culture, economy, and technical capability for investment opportunities and possible barriers.

In the first phase, the project team plays the role of investors from elsewhere, intent on creating or supporting enterprises in the local jurisdiction. They meet with local groups—private sector, financial community, service providers, scientists, and engineers—to get an idea of the climate for business and areas of comparative advantage. They then select a small number of knowledge-based "vanguard enterprises" for investment, each in an advantageous area but technologically a bit beyond existing local businesses. They return with international experts in each of these areas, gather a local group of "stakeholders" who know different aspects of the new enterprises and know the local business environment, and together create business plans for these fictitious enterprises. By comparing local potential to world best-practice, these exercises enable the experts and stakeholders together to identify opportunities for new enterprises and discover local barriers that may prevent their realization. The results of these "virtual case studies" form the basis of the recommendations that are presented at the conclusion of the study.

Prince Edward Island agreed to carry out the first pilot project to test the Knowledge Assessment methodology and at the same time use it to evaluate and to explore opportunities for developing the knowledge economy on the Island. The test of the knowledge economy is efficient use of knowledge resources. It can be measured by the extent to which knowledge is put to use by all sectors of society through profitable knowledge-based enterprises, effective health services, a sustaining and sustainable agricultural system, and a productive educational system, and in the longer term, by the reduction of inequality in society.

Five vanguard enterprises were selected to explore the barriers to putting knowledge to use in PEI, specifically to include a manufacturing business, an enterprise located in a rural area, one that would utilize the Island's telecommunications facilities, and one related to a social sector. The five enterprises were:

1. Chitin production from lobster and crab shells, drawing on the unique availability in close proximity of large amounts of shell, the highly organized processing sector, and the process research capacity of the university and government laboratories;
2. Swine breeding for export, taking advantage of the island status of PEI and the opportunities to increase the biosecurity of the Island and the high capability of the swine breeders to produce low-disease, high-value breeding stock;
3. Electronic commerce, combining the broad-band network existing throughout the Island and the marketing potential of the Anne of Green Gables theme for sales of Island products via the Internet;
4. Wind turbine manufacture, with fabrication, assembly, and testing of wind turbines and components by Island suppliers and contractors and marketing to remote areas of Canada and developing countries; and
5. Telemedicine, using computers and the broad-band network to bring specialized health care capability to rural hospitals.

The recommendations of the Knowledge Assessment were drawn from the analysis of the vanguard enterprises. Among the specific suggestions were:

- creation of a Center for the New Economy, with educational, mentoring, and assistance programs for knowledge-based industry;
- development of an educational program on the Island for would-be investors that would encourage local investment while providing a source of income for a local institution;
- a "youth province" program to introduce young students to new career ideas and build a more self-reliant, entrepreneurial culture;
- establishment of graduate programs at the university in selected areas related to development opportunities for PEI;
- creation of a biosecure zone on PEI that could become a world resource for conservation of vulnerable commercial species and reconstruction of deci-

mated herds or cultivars, while enabling local breeders to produce low-disease, high-value products, to be fully explored at a proposed international conference on PEI on securing the global food supply;

- a survey exploring health, education, and business opportunities to more fully use the capacity of the province's broad-band infrastructure, using information technology and the provincial geographical information system to match needs and outcome with service availability;
- a campaign to recruit and retain skilled workers and professionals from off the Island, with particular attention to former Islanders;
- development of a provincial science and research policy to set priorities and guide the allocation of resources to the research and development community;
- encouragement of first stage financing for knowledge-based enterprise at two levels: microfinancing for small or life-style businesses and venture capital for enterprises with potential for growth.

Following the virtual case studies, some of the participants were already encouraged to form real companies in the same areas, and new partnerships have been formed to further these efforts. These exercises appear to have had a catalytic effect beyond the purposes of the Knowledge Assessment, and it is recommended that the self-examination that is central to the Knowledge Assessment methodology be continued. There may be scope for the Institute of Island Studies to continue its role as a catalyst in this area.

1

Introduction

This is fast becoming a knowledge-oriented world. Creation and distribution of wealth, jobs, education, and health will depend greatly on the ability of a society to make use of knowledge and convert it to products, services, and income. The so-called knowledge economy is characterized by unprecedented competition among jurisdictions and countries, and less importance is given to geography or low wages for finding niches in global value-chains. Each jurisdiction must develop its own strategies for entering the knowledge economy. These strategies should be tested by seeing how they would foster new knowledge-based enterprises and expand markets.

Knowledge Assessment is a diagnostic method to support this type of strategy. It identifies hurdles to access to and use of knowledge and adoption of new technologies, and proposes actions to improve knowledge strategies and infrastructure. It does not try to predict the future, and it is not a substitute for developing a common, progressive vision. Rather, it focuses on eliminating impediments, both to thought and action, so that rational and responsive technology development can take place.

The concept of Knowledge Assessment arose explicitly at a symposium in 1994 on the topic Marshaling Technology for Development,[1] sponsored jointly by the National Research Council (NRC) and the World Bank. Several speakers emphasized the impact that new technologies are having on business practices, spurring the development of new products and services and creating niches in the

[1] *Marshaling Technology for Development*, National Research Council, 1995.

Prince Edward Island at a Glance

Status: Province of Canada		
Land Area:	5,660 Km^2	
Population (1996):	134,557	
Urban Population:	59,460	
Rural Population:	75,097	
Population Density:	23.8 per sq. km (highest in Canada)	
Working Age Population (15 and over), 1997:	107,300	
Labor Force, 1997:	71,100	
Employment Rate:	56.4%	
Unemployment Rate:	14.9% (second highest in Canada)	
Capital: City of Charlottetown, Population	32,531	
Legislative Assembly: 27 members		
Counties and their Population, 1996		
Kings:	19,561	
Queens	70,430	
Prince:	44,566	
Climate:		
Summer average daytime high, July and August:		23.0 degrees Celsius
Winter average daytime high, January and February:		–3.5 degrees Celsius
Average yearly snowfall		275 centimeters

global economy for a new class of players, including formerly developing countries and specialized jurisdictions within larger countries. The Bank asked the NRC to develop a "Knowledge Assessment [process]...to assess a country's ability to capture and generate knowledge, turn it into action, and become ...a 'learning nation.'"[2] The National Research Council formed the Committee on Knowledge Assessment, which included among its members senior scientists, engineers, and executives from university, government, and the private sector, to help design the methodology. The result was published by the National Academy Press[3], and it led NRC to approach several developing countries to initiate a pilot project to test the effectiveness of the process.

[2]Jean-François Rischard, quoted in *Prospectus for National Knowledge Assessment*, National Research Council, 1996. P. 6.

[3]*Prospectus for National Knowledge Assessment*, National Research Council, 1996.

Transportation:		
Airports in Charlottetown and Summerside		
Confederation Bridge to New Brunswick		
Ferries to Caribou, Nova Scotia, and to Grindstone, Magdalen Islands		
GDP, 1997:	$2,943 million	
Average annual growth in GDP, 1992 - 1997:	PEI: 4.7%; Canada: 3.8%	
International exports		
1992:	$174 million	
1997:	$424 million	
Distribution of employment, 1997	PEI	Canada
Primary sector:	12.6%	5.1%
Manufacturing:	9.4%	15.5%
Public sector (including education, health care)	26.8%	22.3%
Other high-knowledge services*	11.5%	20.3%
Other	39.7%	36.8%
Educational Levels, 1996:	PEI	Canada
Degree	12.9%	17.3%
Diploma or Certificate	31.4%	30.7%
Some Post-Secondary	8.6%	9.6%
Secondary Graduation	18.6%	21.6%
Less than Secondary Graduation	28.5%	20.8%

*Includes transportation and communications, storage and utilities; finance, insurance, and real estate; and services to business.

At the same time, Prince Edward Island was beginning to explore its own role in the global knowledge economy. The Institute of Island Studies at the University of Prince Edward Island was leading a three-year public policy initiative to explore strategies for self-reliant economic development for the small islands of the North Atlantic. In a related initiative, the Institute planned a one-day public forum on the knowledge economy to explore opportunities for export of knowledge-based services. In the process of assembling an agenda for the event, a consultant to the Institute found a reference on the World-wide Web to the NRC Knowledge Assessment program. The staff director of the NRC Committee on Knowledge Assessment was invited to visit PEI in July 1997 to discuss the methodology with a wide array of stakeholders. Shortly afterwards, the agreement between the Institute of Island Studies and the Committee to carry out a Knowledge Assessment in Prince Edward Island was formalized. The Institute concluded that the methodology, although intended for developing countries, held considerable promise to build a better understanding of the knowledge economy

and its potential for PEI. The NRC Committee felt that PEI was an ideal venue to test the Knowledge Assessment methodology, where it would not be tied to the promise of a development bank loan and would receive the critical scrutiny normally accorded by jurisdictions to proposals to carry out actions for their own good with their own money. The Knowledge Assessment was supported financially by a number of partners:

- the Knowledge Economy Partnership, an innovative alliance of the federal and provincial governments, PEI's academic institutions, and the private sector;
- the Atlantic Canada Opportunities Agency (ACOA);
- Human Resources Development Canada (HRDC);
- PEI Executive Council Office; and
- the province's telecommunications firm, Island Tel.

In-kind support also was received throughout the project from PEI's two post-secondary institutions, the University of Prince Edward Island and Holland College.

The purpose of this report is to describe the barriers to development of a knowledge economy in Prince Edward Island and suggest some proposed initiatives for creating opportunities for knowledge-based enterprises, as they arose from the Knowledge Assessment methodology. Thus the report is directed at the stakeholders in Prince Edward Island, including the educational institutions, the private sector, and the government, and is intended to be used as a basis for action. The evaluation of the methodology itself, based on this report, will be presented elsewhere.

2

The Knowledge Assessment Methodology

Knowledge Assessment is based on a venture capital model, and involves some role-playing both by the foreign visitors and the local participants. The visitors act as the agents of hypothetical venture capitalists with a potential interest in investing in the local economy. The local participants act as consultants and possible partners anxious to help the investors find the most promising areas in which to invest. They also want to direct the attention of the investors to areas where there may be a perceived weakness in the economy or in the knowledge available so that remedies can be taken that would encourage investment. In later phases, local participants play the roles of stakeholders in the enterprises selected by the investors and help them prepare business plans. In each case, of course, the object is not to select enterprises for real investment but to use this method as a vehicle for exploring the strengths and weaknesses of the local knowledge economy.

The methodology itself has its strengths and weaknesses. Its strength is that it is relatively rapid and low cost. It draws on the knowledge of insiders through strategic questioning by expert outsiders. Its weakness is that the information generated is no better than what is offered by participants (and understood and digested by the visitors), and superficiality, bias, or wishful thinking is a risk. It is not an exact science, but a practical method of eliciting the knowledge possessed and often not explicitly recognized by the local stakeholders.

Knowledge Assessment has three stages. The first is a general baseline inventory of the knowledge infrastructure and knowledge-related services, called in this case the provincial knowledge system. The "investors' agents" wish to understand the environment for knowledge-based enterprise in the local economy.

They choose for their sources the most knowledgeable individuals in several sectors, and interview them in depth in a focus group setting. At the end of the first stage, the investors' agents identify certain areas that are promising for investment.

In the second stage, the virtual case studies, the investors get more specific, and begin to prepare business plans for the several selected "vanguard enterprises." The foreign participants are international experts who are familiar with the technologies and with world standards and wish to test local conditions and possibilities against them to find out what changes might be required in order to make the "ventures" successful. The knowledge-based vanguard enterprises are chosen in sectors of comparative advantage and areas related to the jurisdiction's development goals. Vanguard enterprises are hypothetical enterprises advanced in the use of knowledge *but not yet present in the jurisdiction*; they are selected for their usefulness as a vehicle to explore the strengths and weaknesses of the local knowledge economy. The small number of international experts versed in best practice in each vanguard enterprise work with local experts who play the role of stakeholders to draft a business plan for each hypothetical vanguard enterprise, and in this way they can identify the impediments to the creation and success of real enterprises that are similar to the hypothesized enterprises.

For each case study the international experts then prepare a report describing the impediments identified and making recommendations for overcoming them. The Knowledge Assessment Committee uses the reports of the several case studies to prepare a set of recommendations that would enable the success of knowledge-based enterprises in general, and particularly in the chosen areas. However, whether or not to promote the actual creation of the vanguard enterprises is *not* among the recommendations. No market research will have been done (except to ascertain whether market research *can* be done); so far these are only hypothetical examples used as vehicles to help understand the knowledge economy.

In the third stage, the recommendations are reviewed and critically examined through interviews with key local officials and experts not involved in the virtual case studies before inclusion in the report to government and sponsors.

The final Knowledge Assessment report identifies some core competencies of the jurisdiction and recommends actions and interventions aimed at eliminating barriers to full exploitation of these competencies and the creation and building of knowledge-based enterprises based on them. The recommendations are addressed to government, the private sector, the educational sector, and the communities; there are recommendations with short and long term effects. The long term recommendations aim to improve the level of knowledge and capability in the jurisdiction. The short to medium term recommendations try to take advantage of existing core competencies and forward-looking technologies to reduce barriers to knowledge-based enterprise creation.

3

The Knowledge System

The first stage of the Knowledge Assessment in Prince Edward Island was initiated in Charlottetown on February 24 and 25, 1998, with meetings of four focus groups. The topics of discussion were based on the template of the national knowledge system prepared by the NRC Committee on Knowledge Assessment and adapted for PEI in consultation with an advisory group of the Institute of Island Studies.

The four focus groups represented the private sector, the research community, learning professionals, and non-governmental organizations. The private sector group included officials of firms in the following industries: business consulting, aerospace, information technology, venture capital, construction, potato farming, and telecommunications. The companies ranged from 1 to 300 employees, and have been in existence from 1 to 100 years. In fact the lines were not tightly drawn, and there was considerable overlap among the focus groups. Some individuals served on more than one group, and some institutions were represented on more than one of the groups. A full list of the participants is given in Appendix 1.

CLIMATE FOR THE KNOWLEDGE ECONOMY

Cultural and Political Climate

As a place to live and a place to work, Prince Edward Island has clear and undeniable advantages. Its physical beauty is striking, and this is attested to by the thriving tourist industry and the vacation retreats of numerous wealthy and

less wealthy North Americans. Its climate, while harsh in winter, is comfortable and sunny during the summer months. It has a mythology, attractive to many, of being an island of farmers and fishers, independent and ingenious, hard workers who shun the traditional eight-hour day. At the same time, it is a province of Canada, albeit the smallest, and therefore enjoys (or endures) three levels of government: the federal, the provincial, and the local or municipal. And it has the Confederation Bridge or "Fixed Link" connecting it to the mainland, new and still controversial within PEI but better known than the Island itself throughout much of the world, contrasting a romantic image of lost isolation with a practical one of a new era in communications with the rest of Canada and the world. The real long-term impact of the bridge remains to be seen.

For agriculture, the soil is good, rainfall is plentiful, and Islanders believe the quality of their potato crop is the finest in the world. The province also has a strong livestock sector in dairy, hogs, and beef, made self-sufficient in feed supply through the rotation crops from the potato industry. According to the focus groups, other crops are distinctly secondary and receive much less support from the government.

Islanders see themselves as a race of entrepreneurs. As is true of farmers and fishers everywhere, risk is part of their lives, but they claim to face it with their own brand of common sense (and with comfortable awareness of the Canadian Government's generous social safety net). They have a sense of place, and community is important. The provincial capital, Charlottetown, is a small city of about 30,000, but provides an urban counterpoint to the general rural environment. Infrastructure is generally as good as, and in some cases exceeds, other parts of Canada, with one notable exception: the complete lack of public transportation. The province's railroad, which opened in 1875, was removed in the early 1990s, and the abandoned railbed was converted into hiking, biking, and snowmobiling trails.

The threats that Islanders see to their way of life and their culture have roots in many of the same factors as their strengths. The success of the potato crop has led to over-reliance, and many feel that Island agriculture is reaching its limit in terms of production. Productivity in potatoes is high, but there are adverse environmental impacts from erosion, soil degradation, and excess fertilizer and pesticide applications, and there is limited suitable additional land to be cultivated. There has even been some criticism of the sight of the potato monoculture in the PEI landscape, lacking variety and color, and of the loss of the supplementary income that might be supplied by other crops. However, horticulture thrives in private gardens and is a source of potential expertise.

The harsh winters, combined with the seasonality of farming, fishing, and tourism result in a dependence on Federal Government transfers that many Islanders would like to see diminished. Employment Insurance payments and Equalization Transfers from the wealthiest to the poorest Canadian provinces

dominate the Federal subsidy to the Island economy, and the Federal contribution to the economy was thought to be as much as 50% of GDP.[1]

Perhaps the threat most often pointed out by Islanders is the loss of young people. The population declined throughout the early decades of the century, bottoming out early in the Depression, before entering a period of slow, then steady growth until the present. Its rate of growth has been far less than the rest of Canada, however, and its share of national population has declined significantly. It is almost a tradition for young graduates to leave the Island in search of work or adventure, and only a fraction return. In contrast, the influx of trained people attracted by the environment, culture, or jobs, is felt by Islanders to be unreliable. Newcomers are sometimes not considered "real" Islanders and are thought not likely to stay long. In fact, many do leave after a few years, some in part discouraged by their lack of acceptance into the community. In addition, there are few opportunities for spouses, and the school system is said to be a negative factor to some potential recruits.

The external threat is also on Islanders' minds. The rest of Canada is considered potential competition, especially for Island workers. The economy is highly dependent on the Federal Government, and the threat of Quebec secession is taken seriously here. There are many concessionary programs for the French-speaking population that benefit PEI, and which might be reduced without the influence of Quebec.

Transport and energy costs are higher than in neighboring provinces, although the gap with other provinces has closed significantly in recent years with the opening of the Confederation Bridge and the establishment of a regulatory cap on electricity prices. It is widely believed that industry will not locate in PEI unless it is subsidized at a level at least comparable to that offered by neighboring jurisdictions. In potatoes, Maine and Idaho are among the obvious competing jurisdictions capable of making a technological breakthrough at any time. For labor intensive industry, there is also the specter of China.

The labor force is one of the positive attributes of the Island, according to the private sector participants. Workers like to apply their ingenuity to solve problems, although there is a belief that PEI workers are not well suited to work in situations that require regimentation and offer few opportunities for individual creativity. PEI workers tend to be loyal to their companies, and dedicated to re-

[1]This is an outdated impression, although still valid for total public spending. In April 1998, subsequent to the focus groups, the Atlantic Provinces Economic Council released its study of PEI, *Linked for Good*, which indicated sharp decreases in PEI's dependency on federal and government spending. Net federal spending in PEI (spending and transfers net of revenues raised) declined from 47% of GDP in 1976 to 25% in 1995. Meanwhile, provincial spending (including federal transfers) fell from 33% of GDP in 1980 to 25% in 1995. These decreases in dependency on public sector spending were the largest of any province in Canada. (pp. 17-19).

maining on the Island, despite the promise of higher salaries elsewhere. Labor relations are peaceful, and strikes are rare. In the agricultural sector, there is an adequate labor force to cover the demand of peak periods in spring and fall, which complement the busy tourism season in summer.

The workers who generated the most pride among the focus group participants were those associated with the relatively large arts community. Crafts, writing, and performing arts are highly developed. The low cost of living and perhaps the physical beauty and relative isolation attract many artists and performers into a well-organized community linked with a popular local monthly arts and entertainment publication. Celtic fiddling and piping are internationally renowned, and a community symphony orchestra serves the local population. Many consider the arts a resource that has been insufficiently exploited.

It is claimed that the spirit of entrepreneurship is strong on PEI. Many young persons want to form their own businesses. They are not afraid of risk, and they are not afraid of change. Many people expect their lives to change, and are willing to support new initiatives by government and the private sector if that will enable them to stay and prosper on PEI. A good example is the recently completed Confederation Bridge. This new fixed link to the mainland appeared to break many cultural icons as well as raising environmental concerns, and was fiercely opposed by a vocal minority of Islanders, but a majority of the general population accepted this potentially radical change with little resistance, if not enthusiasm.

Literacy is a problem, according to the focus groups. Many adults, especially in more remote parts of the Island, are not functionally literate, and would have difficulty adapting to the conditions of technological work. There was concern as well about the adequacy of literacy skills among recent high school graduates.

Technological literacy is also considered a problem, but the solution may be more accessible. Recent efforts to expand the use of technology in the schools have met with little enthusiasm among many teachers, who are concerned that computers need to be better integrated into the curriculum, and should be perceived as a tool for learning rather than an end in themselves. Technology training facilities for teachers need to be expanded. Although it is claimed that every school has a broad-band link to the Internet, many schools need more computers and trained teachers if they are to realize the benefits. On the positive side, many students have grown up with video games and are more familiar with computers than their teachers, and an imaginative program may find a good response.

Concerns about gender discrimination are similar to those of other jurisdictions. Women have full access to education and are well represented in most occupations, save agriculture and fishing. They are rare in the "boardroom," a lamentable condition common to most jurisdictions in North America and elsewhere. The focus groups, nearly 90% masculine in composition, were in disagreement whether more young men than women leave the Island. There seems

to be little data on out-migration, although it could be very helpful in designing programs to retain and regain skills on the Island.

Some focus group participants did not consider the media in PEI a strong asset. There is little Island coverage by the national media. Although the Island is well served in terms of the number of local daily and weekly periodicals and radio stations, as well as a CBC television station, it was felt that analysis of local issues needs to be strengthened. More emphasis should be placed on investigative reporting, according to the focus groups. In particular, the role of the media in informing people about the knowledge economy needs to be strengthened. People need to be better aware of the achievements already in place, such as the broadband network. The important initiatives associated with the Knowledge Economy Partnership have not been widely reported, although a symposium related to the Knowledge Assessment received a full page of coverage in one of the local papers.

A suggestion made during one of the focus groups illustrates the combination of cultural advantages and economic isolation. The problem was posed as one of marketing and market penetration, and the suggestion was to coin PEI itself as a brand, relating both to tourism and to product identification. The theme proposed is that PEI is a special place where people do not solely work in offices or at day jobs but enjoy a combination vocation/avocation lifestyle. Independent and creative Islanders enjoy and support music and crafts and are quick to master and adopt technology. The risks of the traditional primary sectors have created an Island of entrepreneurs, and the PEI's small scale allows them to enjoy only "a few degrees of separation" in their daily affairs. This is an appealing image that could be used as a brand to promote tourism and all kinds of products. However, it was pointed out that the danger of such a campaign is that if one "PEI-brand" enterprise fails, it could affect the success of all others. This point was especially relevant to one of the vanguard enterprises, electronic commerce, discussed later in the report.

In accord with this image, many Islanders are attracted by the potential of information technology. It is a tool to enable people based in PEI to serve clients and even telecommute all over the world. It also provides opportunities for small enterprises, and for small communities. Locally grown enterprises are favored, rather than "footloose" call centers or large fabrication facilities that could later be transferred to lower wage sites.

Economic Climate

Most of the industrial sector is composed of small and medium enterprises, the majority of them being family-owned businesses. Many of these serve as suppliers and contractors to large primes such as Allied Signal and Atlantic Turbine. The aerospace companies have attracted a number of spin-offs and startups, and recruited other firms for supporting services such as trucking of engines.

There was some discussion as to whether there is good technical support available for startups, but no disagreement on the difficulty in getting capital for new companies. Some venture capital is available on the Island, but very little of it goes to startups. In general, the government is the lender or grantor of first resort, and several Federal and provincial funding programs are available to support new ventures; again little is awarded to new local firms.

The equivalent situation in the farm sector is the role of the larger, vertically integrated agro-industrial companies. For example, the French fries companies are widely perceived to have a significant degree of control over that part of the potato industry reliant on growing potatoes for processing. They provide the fertilizers and other chemical inputs, and according to one focus group participant, turn some farmers into piece workers. Where the large corporations own the technology, they also tend to appropriate most of the added value.

Illegal or informal transaction costs appear not to be a significant problem in doing business on PEI, and crime rates are low. However, personal relations and connections count for a great deal; this may or may not represent a barrier to new industry on the Island.

Some participants claimed that official figures, which in past years described up to seventy per cent of the economy of PEI as falling in the public sector, are misleading, in that a large contribution to that was employment insurance. In any case, the numbers are falling, and they feel a more accurate figure would be less than half. Even so, many focus group members felt that the government influence is disproportionately large on PEI, and that the Island is "over-governed." The government puts considerable money directly into the economy, but it is not always perceived as effective or useful, and needs a greater strategic vision. More use could be made of planning at the community level, to enable micro inputs for micro opportunities. There also should be a comprehensive plan to follow up initiatives already taken. For example, Island Tel has installed the fiber optic network which makes broad-band communications available all over the Island, including schools, but more effort is needed to take advantage of it to improve public service, education, and business opportunities. Programs should be aimed at ultimate goals, like better science and math education, and not stop at means, like broad-band communications.

The focus groups felt that in past years government intervention has been biased toward heavy industry sectors, like aerospace and agricultural processing. Current provincial government policy seems to favor smaller business, and information technology is now receiving more attention. It also supports alternative forms of agriculture, like emu ranching, ginseng growing, and bioengineered potatoes.

The Government intervenes directly in some areas. It subsidizes industries and loans money to build new plants, relieving the commercial banks of this responsibility and, according to some, the companies of accountability. Many, if not most, of the major industrial initiatives have been subsidized by the govern-

ment, including the recent expansion of Atlantic Turbines and a local software company. This amounts to the government paying directly for jobs, and the question was raised whether this was the most cost-effective means of securing them. It was noted however that it is difficult to stop when other jurisdictions offer similar incentives.

In some areas, government intervention was considered by several participants to be misdirected, specifically for support of the arts. For example, there was some criticism of the large government subsidies for a performance center rather than investment in programs that would have directly benefited local artists and culture on a year-round basis. Some think that the arts are a key to greater prosperity in PEI, and Government investment in the arts, such as support to theaters and festivals, has a high return. Others feel that infrastructure such as a performance center is a more legitimate role for government than direct subsidies to artists, or even businesses. Government subsidy of private enterprises is a Canadian tradition, but it is apparently not without controversy among Canadians.

Some PEI businesses are becoming familiar with international markets and are well linked. PEI potatoes and seed potatoes are sold all over the world. The Island has a good international reputation, promoted by former Islanders living "away."

Taxes, including sales taxes, are seen as high, within the upper third among the Canadian provinces. For new industry, however, the government frequently offers tax holidays, and there are no provincial payroll taxes in PEI.

THE KNOWLEDGE RESOURCE BASE

The creation of new knowledge is an important element of science and engineering and is usually measured by the output of original discoveries or inventions. But discoveries that are new to the province or new in context are equally important with those that are new to the world. Research and development are important both for knowledge creation and human resource development. Creation and dissemination of local knowledge is often of most benefit to local knowledge-based enterprises and essential for competition. A recent study by the U.S. National Science Foundation looked at the papers referenced in patent applications, and found that a majority of them came from researchers within the patent applicant's own country. Even when the local research is not very advanced, an active scientific community plays a role of providing "coupling" to the research going on in the world at large. This coupling may eventually become a two-way flow. The local group learns about research that may become of importance to the Island while the research is still in the nascent state. If the coupling is effective, they can also influence the direction that some of the research is taking. The funds required for such coupling are small, primarily those required for attendance at meetings, journals, and professional visits.

Research and Development

The research enterprise in PEI is limited, but investment is tightly focused, providing PEI with a cluster of facilities in the food science area claimed to be the strongest in Canada east of Montreal. Efforts are being made to capitalize on this cluster through the recent establishment of the "Belvedere Life Sciences Research Group," a partnership aimed a pursuing international research and development opportunities in food production systems, animal health and diagnostics, and technology.

Much of the research going on at the University of Prince Edward Island is carried out at the Atlantic Veterinary College. The only other major post-secondary school is Holland College, a community college with training and adult education programs. Participants feel that the government has lacked a long-term commitment to research and development in favor of instant results in a very few fields. In the Veterinary College, however, the physical laboratory infrastructure is considered to be very good, and the College's particular strengths in epidemiology, herd health, and mariculture were noted.

Outside of the Atlantic Veterinary College, the university is considered by the government primarily a teaching facility, and the professors have relatively little time for research. There are no graduate programs, outside of Veterinary Medicine, and a recent proposal for a Masters in Education was rejected. This "cap" on graduate education at UPEI is embodied in the legislation that established the University in 1969. Establishment of new programs must also obtain the approval of a regional body, the Maritime Provinces Higher Educational Commission (MPHEC), responsible for promoting an efficient and accessible distribution of programs among Maritime universities.[2]

Currently only a small amount of basic research is carried out at the university, supported by grants from federal government agencies and private sector contracts. But researchers are frustrated by the lack of graduate students, and those with a primary interest in research tend to leave. The Veterinary College, with about 65 faculty, carries out research in aquaculture, agriculture, dairy sciences, and swine husbandry, and has good microbiology and biotechnology facilities. Notably absent from the university is research capability in computer sciences, semiconductors, and electronics that might support an IT industry. Outside the veterinary college there is no agricultural research at the university. There is, however, tourism research carried out at the Atlantic Tourism and Hospitality Institute at Holland College, with links to the Business School at UPEI. A new

[2]Following the recent proposal by UPEI for a Masters Degree in Education, the provincial government requested MPHEC to review and recommend on whether the legislative cap should be lifted to allow UPEI to establish graduate programs outside the Veterinary College. MPHEC has recently completed its review, which was under way at the time of the focus group meetings of the Knowledge Assessment, and has submitted a report favorable to the expansion of graduate education at UPEI.

degree, a Bachelor of Business in Tourism and Hospitality, has just been established by UPEI, providing two years of specialized studies following completion of the two-year diploma program at Holland College. This initiative is likely to assist in meeting that industry's research needs.

The federal presence in PEI research is concentrated in the food area. The Agri-Food Canada Research Center has about 90 research personnel and accounts for almost seventy-five per cent of the research effort in PEI. There is also a federal livestock and plant pathology laboratory, the Center for Animal and Plant Health, in Charlottetown. The Center has a P-3 level containment facility, with special facilities for handling and testing sensitive materials. These federal facilities carry out research, with the government retaining the rights to results, which may be licensed by cooperating companies or offered in the market.

There is a Food Technology Center with core funding from the Provincial Government, very well equipped, and staffed with about 20 researchers, mandated to work with and for industry on product and process development and on quality assurance. The Center also has some resources to support research projects from the private sector through matching grants.

There is also some research carried out by industry. Cavendish Farms, part of the Irving Corporation, is engaged in a research collaboration with Monsanto on transgenic potatoes. There is little research on other crops. Another private company, Diagnostic Chemicals, has a good reputation for developing devices used for environmental testing.

Promising areas for research at the university include the marine coastal environment and the potential of mariculture. A key environmental issue is sustaining the estuaries which are under threat from acidity, runoffs, and build-up of sediments. There is also some concern over health problems resulting from pesticides used in agriculture, and organic farming was identified as an emerging market of major potential, requiring research into production, processing, packaging, and marketing.

Focus group participants saw a need for more research in fisheries, especially with regard to lobster. Despite concerns that stocks might be on the verge of decline, little field research is being carried out in PEI and there is no reliable knowledge base. (There is, however, a unique center for lobster health at the Atlantic Veterinary College.) Aquaculture and mariculture have promise for retaining income from presently harvested species that are under threat; production of mussels is already well established. Species selection for local conditions, including management of ducks and other predators of the product, and control of diseases are important research areas. The winter ice cover limits aquaculture of some species, and research is required into fast-growing varieties, management of predators, control of diseases, and good sources of feed. Algae production for feed might be a fruitful enterprise in its own right.

Participants considered much of the existing research to be of a problem-solving nature, with some knowledge gained, but generally not producing salable

results. In part, there seems to be a self-deprecating attitude among researchers about research. Islanders expect experts to come from away and tend to distrust local expertise, at the same time that many of them resent the outsiders. There is no association for the advancement of science to promote research and speak for the research community, and there is no mechanism for agreeing on and implementing priorities in research and development on a sustained basis.

The research focus group heard a brief presentation on the activities of AVC, Inc., a private corporate arm of the Atlantic Veterinary College at the University of Prince Edward Island. The corporation was formed to promote and market research products of the university to an international market. The original focus was on products relating to fish health and pharmaceuticals, and it has now expanded its interests to environmental issues. It is a for-profit subsidiary of the university, whose shareholders are faculty members, and patents are held jointly by faculty researchers and the university. However, to date the experience with patents is limited.

Holland College also has set up a for-profit initiative involving joint ventures with private firms. The likely focus areas are software development, training packages, and enterprise development. The college also plans to establish an Enterprise Development Center to assist in generating new ventures in the information technology area.

Access and Dissemination

Prince Edward Island has full Internet connectivity and good links to the Canadian information system, so access to knowledge itself is not a problem. The greater issue is the link between information provider and user, a role traditionally played by extension agents, technological information and technical assistance services, and consultant firms.

The agricultural extension service has seen some reduction in resources in recent years, and accordingly has shifted its emphasis from one-on-one consultation that provided advice to growers to larger meetings and courses that provide information but not recommendations. The meetings emphasize potatoes and livestock, with less attention to rotation or alternative crops. The extension workers are considered by some not as well informed as the leading growers.

The National Research Council of Canada supports an extension service for industry concentrated in manufacturing and biotechnology. The service is generally good, but there are just four agents assigned to Prince Edward Island.

HUMAN RESOURCES AND DIFFUSION OF KNOWLEDGE

The learning human being is the factor that allows the firm or producer to do new things and remain competitive. This means selection, interpretation, and understanding of information, and the conversion of information to knowledge. Dif-

fusion refers to the flow of knowledge among people and institutions, and the means by which it reaches people who master the knowledge or technology and put it to use.

Human Resources

The business and research groups had much to say about the quality of the educational system, of which they were on the whole critical. The learning and community groups, with greater representation from the teachers and post-secondary faculty, were more positive, but the discussion, and the lack of agreement itself, left a feeling that this is an area that requires further attention.

The critics believed that PEI's proposed knowledge economy is presently not well served by the educational system. After a period of major investment about thirty years ago, which brought the education system on par with other provinces, there is now a perception of stagnation, with an aging workforce and physical plant. Standards vary from school to school, and at present only the university entrance requirements constitute a uniform standard, although secondary graduation outcome requirements are currently being developed through a regional initiative. Some of the focus group concerns included inflated grades, high school graduates who can not write a business letter, dropout rates of twenty-five per cent for males and fifteen per cent for females, the integration of special need students, out of date texts, and the quality of teaching. Neither the schools nor the universities are producing the number and quality of technical workers that are needed for the knowledge economy, and many technology related jobs are going unfilled. (This latter complaint is heard in the U.S. and other industrialized markets as well, as the growth of technology sectors outstrips the educational programs.)

The primary and secondary education systems in PEI are under challenge at present. The mathematics and science curricula are being restructured, and the teachers are struggling. The teachers' union is concerned, calling for more consultation with teachers, and for more resources to help teachers cope with technology and increased workloads.

In recent years, substantial investments have been made in technology, bringing the ratio of computers to students into line with the national average. PEI was the first province in Canada to connect all of its schools to the Internet via a broad-band network. Some teachers claim, however, that investment has focused almost entirely on hardware rather than content development. Without more integration of computers with the curriculum, they feel that much of the educational potential will go unrealized, and that funds will have been drained from other aspects of education for no good purpose.

According to critics, neither the University nor Holland College is sufficiently oriented to preparing trained workers, a complaint frequently heard from employers everywhere. The business leaders felt that the university needs to broaden its

focus and be more open to partnerships with industry; the Veterinary College was cited as a model in this area for the rest of the university. Holland College was felt to be too driven by revenue considerations and criticized for its emphasis on producing income for itself. But Holland College's "competency-based education" approach emphasizes active industry participation in program development, and the College may be suffering more from a problem of marketing outreach to its prospective clients than from lack of capability.

Some felt it was a problem in itself that less than ten per cent of the faculty of the university are Islanders. All admit that retention of new faculty might be improved if more Islanders were recruited, but the law prevents the university from favoring Islanders over other Canadians. Combined with the lack of graduate research programs, the result is that many successful Islanders with research careers return to PEI only in retirement.

In academic terms, Island university graduates seem to do well, earning stipends and awards in good graduate schools. About eighty per cent of the student body of the University is native to the Island. There are few international students. It costs about C$10,000 a year for a Canadian student to attend the University or Holland College, including tuition and living expenses. Costs are somewhat higher at the Atlantic Veterinary College and for foreign students. Although these costs are low by North American standards, many students have financial problems and develop debt loads. The proportion of secondary school graduates going straight on to university has declined since the early 1990s. Holland College enrollments, by contrast, increased seventeen per cent last year. Enrollments in private post-secondary training institutions have also increased sharply. Students seek to leave earlier, and to treat education as an investment, seeking just the skills they think they will need in their work, rather than a broader knowledge background.

The brain drain of young people, especially technically trained students, is one of the chief concerns of the knowledge and development community. Some feel that with new industry coming to the province the brain drain will become less of a problem; the wage gap with the rest of the Atlantic region has declined, and higher salaries are available in PEI in the aerospace and other industries. More graduates are tending to stay on the Island, except in technology-related areas, and in public administration, business, and nursing. There is little tracking of students who have left the province.

Participants believed that if there were graduate educational opportunities, including an MBA, fewer students would leave, and more might be attracted from away. It was suggested in the focus groups that one issue is a governmental fear that allowing graduate degrees, including a proposed M.Ed., would increase the number of teachers with advanced degrees and increase the cost of teachers' salaries. If this assertion is true, it would be a clear demonstration of the choices facing a government promoting a knowledge economy. There may be a simple

conflict between a successful knowledge economy and a low cost educational system, and decisions may have to be made.

One of the underexploited resources of PEI is the diaspora of Islanders living in mainland Canada and abroad. Some have acquired valuable skills in science and technology, business, or management, and others have funds to invest. There was disagreement among the forum participants whether former Islanders could be induced to return or invest. But some jurisdictions with less sense of place than PEI have built successful programs to attract expatriate nationals, and this could be explored. Some suggested a strategy of building an environment that favors knowledge-based enterprise with the hope of attracting Islanders and non-Islanders alike to the physical and cultural beauty of PEI. Such a strategy might be built around the university, but it will be necessary to expand programs and import the skills. A computer sciences masters program might be a place to start, but such initiatives require long lead times and a commitment from the government.

Holland College has developed a timely program of training for industry, employing part-time teachers from private sector companies, and working closely with the companies in design of the programs. It has also developed specialized programs responsive to industrial needs, like tourism. However, as noted above, focus group input also suggested that the College sometimes has difficulty adapting its programs quickly to the needs of new industries.

Distance learning could fill in some of the gaps. There are some courses available from other universities. For example, an MBA can be had from the University of Moncton; the community information center at Wellington serves as liaison for that program in the French language for the Acadian community, and is considering a French M.Ed. as well. The University and Holland College have taken some initial steps to offer distance delivery of extension courses. Both have established centers on campus to help professors prepare material for distance delivery.

Participants disagreed whether it was desirable to partner with an institution, like the University of Moncton, that already has an established distance education program and is able to provide a superior product in PEI. Some saw danger that the institutions in PEI would become mere facilitators for others and unable to attract students and expert faculty to the Island. This is seen by some as a general dilemma for a small university, for developing expertise means raising money, setting priorities, and specializing. Students may not want a specialized university, but prefer to have a choice of programs. Many students see UPEI as the place to be, socially and educationally, after high school when there are few attractive jobs for them. They want the university to serve their needs first, and foreign students and distance education to be secondary. However, many of these students intend to leave PEI after graduation in any case, to "see the world and pay their debts." They expect to remain away to pursue graduate programs, but might be persuaded to stay or to return if graduate degrees were offered, especially in science, business, and the arts.

Possibly the dilemma is not so much the role of the provincial university as the allocation of resources for education. There are many examples in Canada and the world of small universities offering a good liberal education to a general student body, but possessing centers of excellence in selected areas. The issue is one of generating new resources to avoid starving the general educational mission in order to serve a limited clientele. A successful niche strategy might well involve "importing" general courses that could be done better elsewhere and concentrating on a few special offerings unique to the Island and valuable to its economy. Through distance education these could be offered to a global market.

Sharing of Knowledge

Some of the most exciting examples of knowledge sharing in PEI involve the rural communities. The Acadian community in the *Evangéline* area of PEI has prepared an information technology integration and training plan, and has integrated computer-based education and training into the schools, with appropriate support and training for the teachers. There are plans to extend this initiative to small business development and health sectors.

Industry Canada, in partnership with the PEI government, has installed thirty Community Access Program (CAP) sites on the Island to provide public access to the Internet, supplementing the connection to all the schools and public libraries across the province.[3] The local CAP site served as a base in Wellington on which training and for-profit production of computer and Internet-related software products were added. In the Morell region, the CAP site offers computer literacy courses and helps graduates find jobs. Most other CAP sites have not had the same impact on the communities.

Some see the need for innovation centers to support small manufacturers, including those that serve larger companies. There is a business service center in Charlottetown, but participants claimed that as a government facility it was run by civil servants who themselves had little experience in business. Nevertheless they have been helpful by providing information on regulations and advice on interfacing with government. The Canadian NRC industrial extension program, while limited on the Island, is also helpful in sharing technological information and knowledge with small and medium enterprises.

[3]Since the focus groups took place, an additional fifteen CAP sites have been opened, completing the planned total of 45 sites, and giving PEI the densest network of sites and broadest public access to the Internet of any Canadian province—an important initiative in a province where modest incomes preclude home computers for many families.

USE AND APPLICATION OF KNOWLEDGE FOR WEALTH CREATION

Efficient use of knowledge resources is the test of the knowledge economy. It can be measured by the extent to which knowledge is put to use by all sectors of society through profitable knowledge-based enterprises, effective health services, a sustaining and sustainable agricultural system, and a productive educational system. Some of the conditions for success of such enterprises involve the regulatory environment, the access to financing, and the availability of technical services to small and medium enterprises.

Most regulations that affect knowledge-based enterprise in PEI are national, rather than provincial. Exceptions include some of the environmental regulations and various safety-related regulations, which are made at the provincial level. Some participants felt that environmental laws are weaker in PEI than in other provinces, and need to be tightened. The Federal government agencies do provide help to enterprises to meet the requirements of the Federal regulations.

Intellectual property laws provide good coverage, and the government provides consultation services. The high royalties paid for biologically altered potatoes confirm the scope of the laws. Quality control is more problematic. The PEI information industry has not yet adopted ISO quality standards, mostly because of their high cost and the lack of local companies to provide assistance. Nevertheless it will be necessary for dealing in Europe particularly, and ultimately it results in cost savings, so it is expected that most companies will make the effort to comply.

Generally, without government intervention, there is little capital or credit available for start-up enterprises, and as is generally true in the world, the first stage of investment comes from "sweat equity." Banks will make personal, secured or unsecured loans to individuals, but they will rarely loan to a new company. (The owners of one firm recounted having to loan their own money to the new company so it could get a secured loan to establish a credit record. They claimed their knowledge was not considered an asset by the banks.) Likewise, venture capital is not available to the new startup. Venture capitalists favor firms at least two years old, and prefer larger investments for the same reason that banks do—in order to keep their administrative costs low. There are government agencies, such as Enterprise PEI and the Federal Atlantic Canada Opportunities Agency (ACOA), that will provide support after the start-up phase in the form of venture capital or guaranteed loans from commercial banks. But their participation is determined primarily by a calculation of the number of jobs created per dollar, and it does not apply well to information technology or knowledge-based enterprises, where initially the number of jobs is small.

Technical services to enterprises are not widely available in PEI. Members of the business group felt that the service most needed is marketing assistance, and that there is little specialized consulting expertise in PEI to help to find mar-

kets. Some grants are given for attendance at trade shows. The week previous to the focus group sessions, a major trade show on potatoes was held in Charlottetown.

Island producers are encouraged to market to the United States and throughout Canada. Many successful businesses, for example in information technology (IT), may have the capability, but they do not know how to expand their market and seek new capital. The government has some assistance programs, and for established businesses, capital may be available, but in IT that is not the primary need. A system of mentoring by experienced businessmen or women would be more helpful.

The new Information Technology Association of PEI (ITAP) has begun to play this role, but further emphasis might be helpful. Some participants thought budding entrepreneurs can become discouraged by having to contact many different agencies or offices to find out about compliance with regulations or sources of assistance, and "one stop shopping" for assistance with regulations or technical assistance would be useful.

Technology services are likewise in need of strengthening. There are no services for norms, standards, metrology, or calibration on the Island. With the exception of areas covered by the Veterinary College, there are no services providing technical information or assistance with technology choice, management, or quality control. There are no industrial incubators associated with the university, as in some other places.

One participant reminded the focus group that we can not understand the use of knowledge without considering the content, and the content will be the key to success. He noted that multimedia flourished in California because it was born of a marriage of Silicon Valley technology with Hollywood, which provided the content as well as the market. PEI must provide its own content, whether related to the arts, to knowledge of potato cultivation or management of mussels and lobsters, or the unique contributions of the different communities. The knowledge economy must not be associated with unattractive jobs like call centers, but be seen as adding value to tacit and embodied knowledge. Lifelong learning must become ingrained, and the communities must become "telecommunities" in the learning society.

4

The Virtual Case Studies

The virtual case studies are the vehicles for analysis of the strengths and weaknesses of the knowledge system. In the second stage of the Knowledge Assessment, the visiting "investors' agents" and experts join with a group of local experts and "stakeholders" to create a plan for each enterprise. Along the way, they identify barriers to success and suggest actions to eliminate them. The virtual case studies are focused on areas of comparative advantage of the jurisdiction, but the vanguard enterprises are selected to be somewhat more technologically advanced than those that currently exist.

Five vanguard enterprises were selected for study in PEI. These were

1. Chitin production from lobster shells;
2. Swine breeding;
3. Electronic commerce;
4. Wind turbine manufacture; and
5. Telemedicine.

These vanguard enterprises were selected on the basis of eight criteria, as follows:

- They should take account of the comparative advantages of PEI. This was reflected in the choice of chitin manufacture, swine genetics, and electronic commerce.
- They should include an area in which PEI has demonstrated leadership in the region. Swine breeding is such an area.

- They should exploit the resources and human and geographical potential of the province. Chitin manufacture and swine genetics would do this.
- They should have potential for increasing exports. This embraces chitin manufacture, swine genetics, electronic commerce, and wind turbines.
- They should include enterprises dependent on information technology. This is explicit in electronic commerce and telemedicine.
- They should serve to strengthen existing clusters. Chitin manufacture, swine genetics, wind turbines, and electronic commerce relate to existing, successful clusters.
- Some of them should be based in a rural area. That would cover chitin manufacture, swine genetics, and telemedicine.
- They could lead to technical change and expand horizons. Swine genetics and chitin manufacture have this potential.
- They should include an area in a social sector. This is fulfilled by telemedicine.

The case studies are summarized below. The full details are given in the appendices.

CHITIN MANUFACTURE FROM LOBSTER AND CRAB SHELLS

Chitin is one of two kinds of polysaccharides common in nature, which are in fact among the most abundant organic materials in nature; the other is cellulose from plants. One species of plankton alone produces 100 billion tons of chitin per year. This supply, however, is extremely dispersed, and tends to deteriorate rapidly or to chelate with other substances, changing its makeup.

Historically, applications have included wastewater treatment, recovery of protein from egg wastes for animal feed, wound healing, crop protection (from fungi), glue, and color photography. The problem in higher end applications is consistency of the product owing to the variability of the feedstock and the chelating properties of chitin; every batch must be tested.

The virtual case study involved a firm that would extract raw chitin, raw protein, and raw lipids from shells, and prepare refined derivatives of these. The objective was to produce high grade, reliable, quality controlled product. The list of possible applications includes such higher end products as cosmetics, surgical sutures, contact lenses, cholesterol or fat reduction, and basal material for sustained drug release. The company would enter into partnership with the lobster processing plants on the Island, which would stabilize and store lobster and crab shells during the fishing season for continuous production year round. Another potential partner is the Food Technology Center, which would carry out the research necessary to select and refine the technology for the conversion of shell material to chitin and its derivatives and for the efficient manufacture of the expected byproducts, and would provide the sophisticated testing necessary to en-

sure product quality. Diagnostic Chemicals, a leading local biochemical firm, might also play a role in the partnership.

The advantages of PEI are the large quantities of lobster and crab shell available from processors, together with the high degree of structure and organization in the industry and its concentration in a few locations. The Food Technology Center and the Atlantic Veterinary College are able in principle to provide the research and technical support. In broader terms, the study explored PEI's capability to convert organic wastes to value-added products for a regional and international market.

SWINE GENETICS

Pork production is a $31 million industry in Prince Edward Island, producing about 200,000 animals per year. There are about 250 small, highly organized producers, who collectively own the two modern breeding facilities on the Island. The porcine disease burden is relatively low, and with the possibility of limiting access from the mainland, it is proposed to establish a low-disease, biosecure zone for pork production. The vanguard enterprise is designed to export low-disease breeding stock to international markets in the form of 21-day-old breeding females. Longer term export opportunities include embryos, semen, and fertilized eggs; a repository of rare, valuable varieties of hog such as those used in medical research; and genetic rescue and repopulation of hogs from countries affected by disease. The broader principles apply to breeding of high quality seed stock and germ plasm in many agricultural sectors, such as potatoes, poultry, and bees, with the potential to produce more sophisticated biotechnology-based products in a biosecure environment.

ELECTRONIC COMMERCE

Electronic commerce is the name given to advertising and selling through the Internet. The World-wide Web enables businesses to reach millions of potential customers at a cost which is independent of the size of the customer base and independent of location. The virtual case study proposes a linked array of interactive, informative, and retailing Web-sites, as in a commercial mall, with the anchor site providing billing, accounting, shipping, Web-site design, electronic data interchange, electronic funds transfer, and quality assurance services to the participating merchants and the public. The suggested theme is Anne of Green Gables, and the electronic or virtual mall is intended to reach fans of Anne and of PEI worldwide, including former Islanders "away," who would visit the site, obtain information, subscribe to on-line magazines, purchase products and interact with each other and with suppliers. Particular emphasis would be placed on a core audience of young girls who are currently underserved by the Internet and by the computer software industry. The partners in the mall would be providers of retail

goods, tourism products, and cultural and literary products and services on PEI and elsewhere. The study tests the capacity of the information technology infrastructure on PEI, the availability of creative and highly trained designers and marketers, and the handling of security, quality, and intellectual property issues.

WIND TURBINE MANUFACTURE

The wind energy business generates $1 billion in revenues worldwide, with products ranging from 300 watt battery chargers to huge, high technology one-megawatt machines in large arrays. The vanguard enterprise would produce small machines in the range up to 15,000 watts for an off-Island, non-grid connected market, particularly remote Canadian territories and islands and for developing countries. The study tests the capability of PEI to compete in a sophisticated design and manufacturing industry for foreign and distant markets, taking advantage of the existing wind energy test site and the services offered at the Slemon Industrial Park.

TELEMEDICINE

Telemedicine is the use of electronic information and communications technologies to provide and support health care when distance separates the participants. Various telemedicine services are becoming widely and even routinely used where there is disparity in the health services available to remote or disadvantaged populations. The service discussed for PEI would establish facilities at the seven hospitals and provide clinical consultation service and continuing medical education. Specifically, regularly scheduled consultation clinics would be offered in rural areas in selected specialties, such as cardiology, dermatology, allergy, endocrinology, and psychiatry, plus a series of medical education courses made available to doctors, nurses, and allied health professionals. Other lectures would be offered for patient education on diabetes, weight loss, smoking addiction, and other topics. The study explored the capability of the telecommunications infrastructure and the receptivity of professional service providers to technological innovation in their areas.

5

Discussion

An *Economist* magazine survey in April 1997[1] explored the secret of the success of Silicon Valley as the incubator of successful high technology enterprises, emulated throughout the world. Silicon Valley has been an undisputed success in these terms, but it is a model that few other jurisdictions have successfully duplicated. Nevertheless, it is instructive to examine briefly the factors that *The Economist* considered key to the proliferation of profitable high technology companies, studied and copied around the world. A surprisingly similar list is given by David Landes describing the factors that led to the growth of industrial society in England that was noted by Adam Smith.[2]

According to *The Economist*, the four classic conditions are:

- the size and flexibility of the labor pool;
- the breadth of the network of suppliers;
- access to venture capital;
- excellence of the education facilities and research institutions.

The Economist also identified several cultural factors that distinguish Silicon Valley from other centers of technological progress less successful in the development of new local enterprises:

[1]A Survey of Silicon Valley: Future Perfect, *The Economist,* March 29-April 4, 1997, following p. 60.

[2]David Landes, *The Wealth and Poverty of Nations,* W.W. Norton and Co. 1998. p. 215ff.

- Tolerance of failure (ability to recover from bankruptcy and try again, sadder but wiser);
- Tolerance of disloyalty (capacity to move from company to company without losing status);
- Risk seeking spirit;
- Reinvestment in the community (many of the profits went into new local companies);
- Enthusiasm for change, or nimbleness to adapt to changing circumstances;
- Promotion on merit; openness to immigrants and women;
- Obsession with the product (the engineering mentality);
- Collaboration (mutual assistance and discussion);
- Variety (a mix of different types of companies in the cluster; if one doesn't make it, another might);
- "Anybody can play" attitude (lack of jealousy, because anyone might make it big).

One additional factor was proposed during the Knowledge Assessment discussions in PEI. Many of the successful enterprises that arose in Silicon Valley were described as a marriage of a technology with a medium: information technology with Hollywood. Thus we may add one more to the *Economist* list:

- A medium or a message that provides a content link among firms.

Silicon Valley is not to be proposed as a model for Prince Edward Island, but it is instructive to see which factors are indeed present, and to attempt to make the most of them. Silicon Valley is one form of economic ecosystem that breeds certain kinds of companies; others will have different environmental conditions and may be suitable for different types of enterprises. In particular, the indices for Silicon Valley must be scaled down to correspond to the population, and indeed the aspirations, of PEI—Silicon Valley does not have a notable tourist industry nor a majority of long-term residents who wish to preserve their way of life. With this caveat, let us examine the "classic" indicators.

LABOR POOL

As an island with a small population, PEI can not pretend to have a large labor pool, but there is a presumed reserve consisting of graduates, who leave the Island for work or advanced study because they find limited opportunities, and the Islanders-away (and others), who would welcome an opportunity to return or settle in the PEI environment. The existing PEI workforce is described as inventive, loyal, and reliable, and wage levels are low in comparison with the rest of North America.

NETWORK OF SUPPLIERS

In the analysis of the five vanguard enterprises, it was found that nearly all the suppliers and contractors required could be found on the Island or, at worst, elsewhere in Atlantic Canada. Products for which component suppliers could not be found on the Island were judged impractical for other reasons related to market or transport; one example was high output wind turbines.

VENTURE CAPITAL

Venture capital is available on the Island. In addition, there are official or unofficial sources of financing for knowledge-based enterprise such as Enterprise PEI, ACOA, and the Immigrant Investors Fund. However, the private sector venture capital funds, or "business angels" tend not to support the kind of startups, or "gazelle firms" that are the core of Silicon Valley, and the government sources may be inappropriate for proprietary reasons for a new firm with a technology to protect. A proposal in this regard is described below.

EDUCATIONAL FACILITIES AND RESEARCH INSTITUTIONS

This area is perhaps a weakness in PEI. The university system's research facilities and programs are concentrated in veterinary medicine, and government laboratories, while first rate, are oriented to serving paying customers and responding to the priorities of their funding sources, which are largely external to PEI.

The cultural factors listed by *The Economist* can only serve as a backdrop to the discussion of the cultural factors that characterize PEI. Pride in and loyalty to the place ranks high in the attributes of the work force. Its translation into return of investment to the Island takes the form of investment funds supported by prominent families or by new residents determined to build the Island's economy. On the other hand, government spending accounts for nearly half the economy, and a substantial fraction of the population is seasonally employed and frequently relies on unemployment insurance. Some entrepreneurs complain of the basket of crabs syndrome: the successful individual is pulled down by others not so fortunate or less ambitious. It must be noted, however, that the Silicon Valley counterpart, the "anybody can play" attitude, was fostered no doubt by the visible examples of success of a generation of young entrepreneurs, and is not an inborn cultural trait. The one is as natural as the other in a different business climate, and is more a positive-feedback response to the presence or lack of opportunities. The same is true of so-called tolerance of failure and tolerance of disloyalty, although these have a basis in law—bankruptcy laws and industrial espionage laws. Neither has been identified as an obstacle to enterprise creation in PEI. In collaboration, PEI is high on the list, and several industries, including aerospace, potatoes, in-

formation technology, and swine, are highly organized, with powerful producers' organizations which provide key technical services to members.

The last category that arose during a discussion precisely of Silicon Valley in the course of this Knowledge Assessment was the question of message. The participants in the virtual case study on electronic commerce were led by the foreign visitors to consider a consistent theme for a set of commercial activities that would unify them and anchor them to the charm and reputation of Prince Edward Island, that of Anne of Green Gables, a concept explored further in the Recommendations section below. The idea of a trademark for PEI has its dangers, such as the vulnerability of the reputation of all parties to poor quality products by one. Overall, the risk would seem to be minimal and the benefit great, and it is suggested that more consideration be given to developing a "PEI brand" for the province's products and services.

6

Recommendations

By the nature and spirit of the Knowledge Assessment exercise, the recommendations are based largely on the information given and the views expressed by the participants in the various meetings and fora. These people are stakeholders in the future progress of PEI, and have deep knowledge of how the Island economy works. Nevertheless, disagreement and even controversy among the participants marked several of the meetings, and this report represents the committee's best effort to arrive at a reasonable picture of the Island, from which the recommendations follow. By the same token, it was not possible to become aware in a short time of all the initiatives that already have been taken in the recent and distant past in each area. Consequently, the comment, "been there; done that; didn't work," was frequently heard.

It would be foolish to fail to learn from the past. On the other hand, a feeling that there is a present need for new initiatives motivated the proposals made here. It is possible that if in fact there had been an earlier similar initiative, it was not demonstrably effective. It is possible that it had not been in place long enough to have realized its potential benefits. It may also be that the earlier initiative was well conceived and well executed, but was "before its time." Sometimes an effort may fail because the time was not right, and a repeat effort could be successful. In any case, there may be value in suggesting ideas that have already been tried in PEI, simply so that they might contribute to understanding whether the earlier attempts failed, and, if so, why.

The proposals described below arose implicitly or explicitly from the virtual case studies. This means that the participants identified a barrier to the success of "their" enterprise and suggested a solution. These suggestions were generalized

and details were filled in, and they were discussed in interviews with other potential stakeholders and public officials during the validation phase. The table below describes in general terms the origin of each of the proposals. An X in a column indicates that the findings of the case study contributed to the recommendation. XX indicates that it was the principal source.

CLIMATE FOR THE NEW ECONOMY

The experience of successful centers of enterprise creation like Silicon Valley has led many jurisdictions to create business incubators and development centers to try to duplicate that environment. However, the specific issues that arose in the virtual case studies did not lend themselves to remedy through incubators, and we hesitate to recommend such initiatives. More to the point appear to be cultural factors and the difficulty of securing resources, both material and human.

Recommendation	Chitin Production	Swine Breeding	Electronic Commerce	Wind Turbine Manufacture	Telemedicine
Center for the New Economy; training for investors	X		XX	X	
Survey of telecommunications potential			X		XX
Anne of Green Gables theme			XX		
Research policy	XX	X			
Biosecurity		XX			
Education and training; Youth Province	X	X	XX	X	
Recruitment of Islanders-away			XX	X	
First stage financing; microloans	X		XX	X	

Center for the New Economy

Consequently, we propose consideration of a rather different type of facility, a center to assist, mentor, encourage, and educate entrepreneurs, that could play a central role in addressing these issues. In the box, an example called the Center for the New Economy (CNE) is described. Among the types of assistance made available would be self-help legal services, marketing advice and assistance, and mentoring. As important as services to existing and emerging businesses, however, would be the educational value for students at all levels.

Along with financing, training and assistance are most important to promote the entrepreneurial class. Training in new venture creation is a relatively new discipline, and PEI could become a leader in this area. The training is important for two groups of clients. One is the entrepreneur. Such initiatives as mentoring programs, organized within the private sector, have been shown to be effective in other jurisdictions. For example, an aspiring entrepreneur can be assigned an experienced business executive to advise him or her on a systematic or informal basis. It could also be a vehicle for recruiting from the Islanders-away community. Successful former Islanders might be pleased to advise a young entrepreneur on the Island, and interest ignited in this way could result later in deeper involvement.

There are services required for quality control and compliance with international regulations in the new economy that should be made available in PEI. Some of them could be provided or coordinated through the Center. Training and certification for ISO 9000 compliance, as well as Good Laboratory Practices and Good Manufacturing Practices, will be required for export of high quality products. Technical services such as norms, standards, metrology, and calibration would serve industry while potentially providing a training resource for students. Coordination of marketing campaigns, expensive from PEI because of the high cost of travel from the Island, could involve an off-Island marketing office available to serve as a focus for Island business. To the extent that these initiatives require collaboration in the common interest among a variety of businesses and producers, the Center might serve as the organizing force.

Elements of the CNE have been in use in many places for a long time. One example is the Initiative for a Competitive Inner City (ICIC) in Kansas City, Missouri. This is an experimental partnership that includes, among others, Harvard University, the University of Missouri, and the Ewing Marion Kauffman Foundation. The idea is to build on the competitive advantages inherent in an inner city location to stimulate private enterprise there. A package of services, not unlike those proposed for the CNE but specifically tailored for the urban core, is offered to small businesses that locate there. The CNE designed for PEI likewise will be organized to respond to a specific, identifiable set of needs. It will provide and integrate a set of services that are tailored to the economic needs of PEI and

Center for The New Economy

If the art of new venture creation can be taught, and if action can be taken to improve the cultural propensity for entrepreneurship, then the issue arises of what kind of institution is best suited to those tasks. This is a sketch of one of many ways that such an institution might be created on Prince Edward Island. Its purpose is to stimulate discussion, rather than set out a prescribed solution, which must originate within the Island if it is to be effective.

A *Center for the New Economy* (CNE) could be created as a joint public-private partnership. The CNE would have three functions. First, it would serve as the locus for discussion of the new knowledge-based economy and issues surrounding it. Second, it would be a center for research on entrepreneurship and new venture creation within the specific context of Prince Edward Island. And third, it would be the platform for the development and use of teaching programs on entrepreneurship and the new economy. These teaching programs would include the primary and secondary schools, the colleges and universities, and executive education for the business community.

The partners in creating the CNE should be drawn from all segments of the PEI economy, public and private. Each must have a stake in the success of the CNE and each must be able to participate effectively in its governance. A leader must be found with both an understanding of entrepreneurial behavior and with an appreciation for the unique PEI culture in which it would be embedded. A Board of Directors that holds fiduciary responsibility and represents effectively the interests of all stakeholders should be chosen.

The kinds of program that a CNE would seem uniquely suited to develop include:

- encouraging and enabling a dynamic, entrepreneurial culture on the Island through educational programs at the primary and secondary school level;
- linking the technology base of PEI, private as well as university, with entrepreneurial courses, if possible at the graduate level, in the universities;
- creating effective mentorship for new ventures, in part through expatriate Islanders who might be induced to return, if only briefly;
- enabling the wise use of capital resources by both government and private investors, especially for first stage venture investment; and,
- providing or arranging for facilities and support for new ventures with the potential for significant growth.

This prototype, or one like it, could be used as the point of departure for an Island conference aimed at designing such an institution. The conference could set out the key desiderata, and a design team appointed to complete the job and select a leader.

that mesh with and support its unique culture. Accordingly, it will evolve in structure and function as its experience grows and as the economy of PEI matures.

Training for Venture Capitalists

The other sort of training is relatively untested. This is training for venture investors, an activity that requires no less skill than the entrepreneur's. Knowledge of management, finance, schemes for taking—and relinquishing—equity, and of finding sources of technical assistance for a fledgling enterprise are the basic elements. Such a program could attract prospective investors from the entire Atlantic Region, or wider. It could be presented in a high technology format led by experienced investors from New York or Toronto or in an agreeable elderhostel type format for the retired investor, including the retired Islander.

THE KNOWLEDGE RESOURCE BASE

The absence or availability of the technologies necessary to create knowledge-based enterprises was a major focus of the virtual case studies. There we started with the opportunity and explored whether the resources necessary to realize it were available or achievable on PEI. It is possible also to reverse the process. Something along these lines was done when Island Tel decided to create a broad-band backbone throughout the Island. Cap sites, points of presence, and broad-band installations appeared in schools, libraries, and community centers, ready to be expanded to businesses for a relatively low additional fee. To date, however, applications have barely begun to tap the capacity of the infrastructure. But the opportunity remains, and we would suggest a further effort to capitalize on it.

Survey of Telecommunications Potential

The telemedicine case study produced a recommendation that a survey be held to determine by geographic location the incidence of certain diseases or conditions, patterns of morbidity and mortality, and the location of the corresponding medical services or specialties for assistance in strategic planning and marketing of telemedicine facilities. With use of a geographical information system package, this could be an effective tool for marketing as well as planning. We would propose that such a survey be carried out, and it also explore opportunities or needs for other services that would take advantage of the telecommunications potential of PEI. Distance education, high speed Internet usage, information services, and other unmet and unrealized opportunities should be explored in order to put to work the high powered network that would be the envy of any jurisdiction. As a follow-up, Island Tel might consider offering shared or fractional lines that would allow users to match band width to need at a lower cost.

Anne of Green Gables

The electronic commerce case study discusses the significant opportunities in the area of creating applications and content for the IT sector, particularly the Internet. While the rapid growth of the Internet creates new opportunities, however, it also makes it more and more difficult to stand out among the millions of competing Web-sites. Gifted writing and graphic design will become essential to success; so will having a unique and interesting story to tell. In this regard, PEI has some features and attributes that are known world-wide, most notably *Anne of Green Gables* (see box) and the Confederation Bridge, which offer significant

The Anne-With-An-E Brand

Anne of Green Gables is, in the words of Mark Twain, "the dearest, and most loveable child in fiction since the immortal Alice." The book, penned by Prince Edward Island author Lucy Maud Montgomery in 1908, has sold tens of millions of copies world-wide, and been translated into dozens of languages. Although its appeal to young people (as well as a growing audience of adult readers) is universal, the book and its sequels, with their twin attributes of a strong independent heroine and lyrical descriptions of the physical beauty of Prince Edward Island, have found particular resonance in Japan.

Indeed, the Anne character's recognition far outstrips that accorded PEI itself. Senior Japanese executives, polled on the potential for language courses in PEI, had by and large never heard of the place before, but every one knew of the "Island of Anne of the Red Hair." The global penetration of this highly positive image and theme were characterized in the virtual case study as a marketer's dream, creating substantial opportunities for PEI.

As profiled in the virtual case study, direct development of the Anne theme itself in electronic commerce can open doors to a host of other PEI products and services. More generally, the "Anne brand" can be used to complement and advance a broader "PEI brand" strategy, creating linkages and establishing a positive climate of acceptance. The emphasis in the Anne books on PEI's exceptional beauty and wholesomeness provide powerful reinforcements to the qualities to be associated with the PEI brand.

To realize these benefits, it is essential that PEI secure rights to the electronic Anne image and theme. In light of the current bewildering diversity of images and depictions of Anne, the opportunity to create a more consistent image for the theme should also be explored. Priority should then be given to high-quality, strategic development of the Anne theme and establishment of the Anne brand as an exclusive attribute of PEI.

comparative advantages to PEI if effectively exploited. Other unique characteristics of PEI, such as its "Island way of life" and its distinctive culture and heritage may not be as well known globally, but also have substantial promise to help PEI stand out and succeed in the global electronic marketplace and society. Emphasis should be placed on identifying, securing rights to, and exploiting these themes.

Research and Development Policy

In two of the knowledge-based opportunities that were explored through virtual case studies, chitin and swine breeding, research on a pilot plant level was an essential prerequisite to determining the feasibility or the success of the vanguard enterprise. In some technical areas, PEI is well supplied with research capability; notable among these is veterinary medicine, agriculture, and food technology. In other areas the capacity is not so apparent. The source that a knowledge-based enterprise might approach in other jurisdictions—graduate students and their professors at the university—are not present in most fields. We would propose that special, urgent attention be placed on establishing research programs at the university in fields of most economic importance to PEI. We also urge that sufficient flexibility be afforded to the Federal and provincial laboratories to carry out generic technological research to benefit producers on the Island, even where it does not maximize net income. This could be contract research, with appropriate proprietary safeguards, or exploratory research that could benefit classes of enterprises.

A provincial research policy should be developed to guide the allocation of resources to the research and development establishment. This policy should be based on a clear understanding of the extent, nature, and quality of the current research effort throughout the province. It should lead to a competitive portfolio of research initiatives, from basic research intended to encourage student and researcher interest in such areas as marine sciences, agronomy, and computer sciences to applied research in the potato, crustacean, or tourism sectors. The portfolio principle, borrowed from Bay Street or Wall Street, means that not every research project must be a success, and risks are justified, so long as the cumulative results from all the projects result in a net long term gain for the province. Included in the calculation should be also the awareness of discoveries and advances elsewhere that research programs will bring to the province. A Premier's advisory council of prominent scientists or an association for the advancement of science could mobilize the technical community in this effort, while bringing many other benefits in terms of linkages and public awareness.

Biosecurity

Knowledge resources will appear in many forms, as does knowledge itself. Some will be technologies amenable to research and development, but there will

be other types of knowledge resource that can be exploited for the prosperity of the Island. One such resource is the potential for establishing PEI as an island of biosecurity for the purpose of raising seed crops and breeding herds of high value. This concept was at the heart of the virtual case study of swine breeding; details are given in Appendix 3 and in the box in this section.

We see biosecurity as a resource that can have international value beyond swine, potatoes, and the particular local products of PEI. In recent memory, the world has seen devastating disease decimate the swine herds of Taiwan and Haiti, and a retrovirus threatens the poultry industry of North America. Prince Edward Island could offer a resource that would help secure the world's food supply, either as a depository of germ plasm or a facility for reconstituting decimated herds.

There are several advantages to PEI as a biosecure reserve. Most obviously, it is an island with only one land link. It is big enough to have a viable and mixed agriculture sector with crops and livestock and agricultural research in place, but small enough to control transit of agricultural products. The crops in rotation with potatoes—forages, grains, and legumes—make PEI self-sufficient in feeds. The livestock industries also provide valuable manure soil enhancers. The soil, albeit not fertile, is considered among the best in Canada for agriculture with suitable amendments, being stone-free and relatively level, and therefore suited to a wide range of temperate climate crops. Producers in several sectors are highly organized, capable of establishing and pursuing a strategic direction. Past examples of quality control include the eradication of bacterial ring rot in potatoes and maintenance of low-disease status for bees and strawberries and high health hogs.

We recommend that a world conference be convened, in which the World Bank, the United Nations Food and Agriculture Organization, and the International Board for Plant Genetic Resources (IBPGR) be asked to play major roles, in order to consider issues related to the security of the global food system and examine the opportunities for designating PEI a world biosecure area. Other International Agricultural Research Centers associated with the World Bank-led Consultative Group on International Agricultural Research should be included as well to explore opportunities for links with the University. Following the conference, an action plan can be prepared for implementing the recommendations. However, it is important also to analyze what, if any, development or lifestyle alternatives might be foreclosed by the controls necessary for biosecurity. Among the issues to be considered are the annoyance of searches at the crossing and objections in the World Trade Organization from countries whose products are excluded.

HUMAN RESOURCE DEVELOPMENT

It is sometimes said that the asset whose value appreciates, not depreciates, with time is the learning human being. Learning is not something that begins and

Biosecurity

Prince Edward Island has characteristics that make it compatible with a special niche in high technology agriculture. The fact that the province is surrounded by the sea with one main point of entry provides the opportunity to develop a secure zone for the breeding and development of feedstocks of various animals, plants, and insects. Current examples of low-disease commodities produced in PEI are swine, potatoes, strawberries, bees, and aquaculture broodstocks.

Agricultural industries worldwide are striving to compete in the global market where commodities are traded freely and low cost production is usually the determinate of success. However, an important component of low cost commodity production is a source of low disease breeding stock. There is risk in raising breeding stock close to centers of intense, high volume production because of the possible spread of common diseases. Producers are cautious about buying breeding stock that may bring a new disease challenge into their operation, so they demand "clean" stock.

PEI could control the entry of plants and animals to establish a biosecure zone for the propagation of breeding stock or nursery stock. These ventures are more profitable than commodity production but require more technology and research support, such as diagnostic services, epidemiology, genetic improvement, and cryopreservation. These ventures tend to be smaller than the commercial prototype raising animals or plants, and could be compatible with the pastoral setting and tourism industries.

Combining technology available from the Belvedere Group of research facilities with the geographic characteristics of the Island could allow ventures to develop that serve commodity production worldwide. Certain strains of animals, such as pigs genetically engineered to provide organs for human organ transplant or blood transfusion, are extremely valuable. PEI could become a safe haven for these strains away from the risks posed by high volume production in a non-biosecure area.

In addition to technological support, a biosecure zone would have to be maintained by controlling commerce and movement of biological materials. PEI would need more stringent rules on transport of plants and animals than would provinces or countries without a low disease status. Policy priorities are different for the production of genetic-based products (breeding stock) than for commodity production. Such policy requirements could be seen as trade barriers by other jurisdictions unless these special needs are adequately defined, explained, and defended. However such efforts in policy and regulation development can foster venture development on the Island.

ends in school but must go on throughout life. But as children learn other skills at schools, so do they learn to learn.

Education and Training

Much of today's, and certainly tomorrow's, learning will involve the use of computers. Computers should be incorporated into the learning process at the earliest possible stage. The students can not be prepared for work, scholarship, or a full life without becoming familiar with what is becoming an essential tool for nearly all human economic activity. Leaving computer literacy for the home is an unacceptable kind of elitism, for not every home has a Nintendo, still less a computer. It will not be long before a school without computers will seem as anachronistic as a business today without computers. Should the educational enterprise be the last sector of society to embrace this transforming technology?

At the secondary level, such devices as science fairs and enterprise clubs provide the incentives and motivations for students to think about entrepreneurship. Youth Province described below is another example of an activity that could stimulate thought about careers, skills, and entrepreneurship.

At the university or college level, the goal must be to train and retain the most talented and energetic students. At present most students who intend to pursue graduate education must go off-island. There they often become engaged in the local technical and educational community, are subject to recruitment by local, national, or international companies, and are less likely to return to PEI upon graduation. Another loss of talent to PEI is the graduate who for any reason does not wish to leave the Island, and is therefore unable to continue his or her education in such fields as computer science, business administration, or biotechnology. A small number of high quality masters and eventually even doctoral programs in selected fields of particular advantage to PEI, like marine science and engineering, would change the climate of education on the Island. The additional benefit to the local economy would come from the presence of a cadre of research professors and graduate students, available for consultation and employment with local industry. This should be a high priority of the new knowledge economy.

Recruitment of Islanders-away

Of more immediate impact would be a program or campaign of recruitment and retention of skilled people from off-Island. A jobs-net that placed advertisements in major North American journals and magazines and set up recruitment tables at selected technical conferences has been effective for other jurisdictions. So might be a campaign that specifically targeted Islanders-away, from new graduates to experienced, skilled, and wealthy individuals at the peak of their careers. Many developing countries have been able to profit from efforts aimed at

Youth Province

As a magician may once have said, "If you want to pull a rabbit out of the hat at the end of your act, you have to put the rabbit in before the act begins." If the entrepreneurial spirit is to blossom in the graduate, it should be planted in the student. A way of engaging the school population at an early age in the opportunities in business is the so-called "Youth Province." During a week's school holiday, students from all over the province could run and operate their own mini-province. They would elect their own political leaders and appoint judges and lawyers. Some will take the role of businessmen and women and start businesses. Others will be bankers and offer them financing (or not!). To be successful, the exercise must be prepared for several weeks in advance with special classes explaining the functions of the various parts of society and the economy that they will be enacting. The experience of several cities in North America that have carried out this type of activity has been very positive. It helps children as young as sixth grade to understand in a hands-on practicum how society works, and enables some of them to realize that there is an entrepreneurial alternative to a "normal" nine-to-five salary job, one that will involve training, initiative, and hard work, but is within their grasp.

recovering the lost subjects of an earlier brain drain, who return to their homeland bringing back their education, experience, and resources. Turkey, Peru, Malaysia, and more recently China, provide examples of what can be done through alumni programs, tours of the homeland, and advertising campaigns.

Priority should be given not only to regaining some of this talent, but also to retaining talent that has not yet left. Although Islanders' intense loyalty to place was cited as one of the strengths of PEI, it should not be taken for granted. If these goals are to be achieved, a change in attitude and a change in image may be required. For example, prominent among the features of the Island that are used to attract new industry is the low wage structure of the Island. It is sometimes compared by boosters to Mexico as an attractive site for labor-intensive industry. It is clear that the same image will not be helpful in the attempt to attract new knowledge workers.

Consideration should also be given to investing year-round in culture and cultural activities, both in society at large and within the school system. This would enhance the quality of life, and maintain and strengthen the sense of attachment and identity that Islanders hold about their home province. It would also foster and encourage the creativity, which is a strength of the Island, and a key asset in the rapid growth of content aspects of information technology.

Finally, another aspect that attracts the kind of skilled, energetic personali-

ties that are required for the knowledge economy is a competitive atmosphere. The famous examples of Silicon Valley, Route 128, and others were known as places where one could make it big, but also as places where many would fail, some more than once, but where one could fail and recover to try again and succeed. An atmosphere of protection by government and of subsidies to weaker competitors is not one that attracts or breeds winners.

USE AND APPLICATION OF KNOWLEDGE FOR WEALTH CREATION

Perhaps the most important predictor of the success of a jurisdiction in the global economy is the economic and social climate that is presented to the would-be innovator and entrepreneur. We have seen some of the indicators that are presumed to have led to the success of Silicon Valley, but there is little justification for trying to duplicate all of these in a totally different environment. Nevertheless, there are some initiatives that can be taken to influence the ecology of business and technology.

First Stage Financing

PEI can establish its own reputation as a cauldron of new opportunities, of success stories, and exciting startups. There are many elements to the development strategy, but none is perhaps more important than giving people an opportunity to pursue their dreams and ambitions. PEI has a generous attitude toward support of enterprises, especially direct financing from the government through such mechanisms as Enterprise PEI, Atlantic Canada Opportunities Agency (ACOA), Agriculture and Agri-Food Canada, and Industry Canada, and various tax measures that favor business coming to the province. There are private venture capital companies as well that have invested in the Island. The element that is largely missing is first stage financing, or seed capital.

First stage financing by its nature carries high risk. Successful private venture investors often have to write off four or more failures for each success; what makes it lucrative is that the payoff from success may be very high. Successful venture financing also requires skill in managing the risks inherent in a new venture and in recognizing the quality of a management team. Those that follow narrow bureaucratic rules or principles are less likely to develop profitable portfolios than those that invest in people, recognizing dynamic leadership, special knowledge, and a skilled and dedicated management team without preconceived ideas about favored sectors, number of jobs generated, or other arbitrary criteria. In particular, in the knowledge economy of today, appropriate recognition must be given to knowledge assets, as well as physical and capital assets, as a predictor of success. An independent board of directors of a facility that understands man-

The Alternative Agricultural Research and Commercialization Corporation

The Alternative Agricultural Research and Commercialization Corporation (AARC) is a wholly-owned corporation of the U.S. Department of Agriculture. It was set up in 1992 as a venture capital firm that makes investments in companies to help commercialize agriculturally based industrial products, non-food and non-feed, from agricultural and forestry materials and animal byproducts. An eleven-person board of directors provides policy and program directions, with at least eight coming from the private sector, representing processing, financial, producer, and scientific interests. The board decides in which projects to invest.

The Corporation receives an annual appropriation from the U.S. Congress. The number and size of awards are limited only by the amount of money available in the fund at any given time; the average initial investment in a company is $300,000. Applicants are expected to bring at least an equal match to the Federal funds. The AARC Corporation expects to recover its investments, plus a premium for the risk it has assumed. Its investments typically include an equity position, a royalty on sales, or a combination of the two. Usually, the agreements include an exit strategy for both parties within six to eight years. The AARC Corporation maintains a revolving fund, into which repayments from investments are placed for reinvestment in other companies or product lines.

Most of the Corporation's clients are small, rural-based firms. Preference is given to funding pre-commercialization activities in companies that already have marketable products, projects that benefit rural communities, and projects that are environmentally friendly. In its first five years of operation, the Corporation has invested $33 million in Federal funds and leveraged $105 million in private funds in seventy projects.

agement principles and invests in people is more likely to promote growth industries and lead to success and profit for the Island.

There are several models that would add business intelligence to the decision process and effectively guide government investing. One of the more interesting is the AARC Corporation set up by the U.S. Department of Agriculture (See box). But with this or other similar schemes, it is important to keep in mind that the payoff from venture investing comes from having a profitable portfolio dominated by a minority of large successes, not a collection of modest, safe picks. Risk necessarily involves some failure, but for the long term development of growth industries that will lead to more, higher paying jobs, some risk-taking is required, and that in turn will necessitate some separation between government accountability and the decision making of the risk-taking entity.

Regardless of the eventual benefit to the total economy of the Island, venture

capital is considered by many people to be an elitist activity. Thus the venture capital initiative might well be supplemented with other programs designed to encourage the fullest participation in the knowledge economy. For example, small loans, of, say, less than $20,000, can be targeted to support life-style enterprises: small retail or service businesses or franchises of larger companies that typically employ a handful of people but rarely lead to growth industries. Nevertheless such loans can be available to a majority of less well trained or financed individuals and command high societal support, besides fostering a spirit of enterprise. Here too, success is measured by rate of return to the entire portfolio, and it will be necessary to separate the decision making from political accountability. An independent board of directors with known skills and with absolute discretion to select recipients according to broad economic criteria will lead to better decision making and insulate the government from charges of favoritism or responsibility for losses. Microlending has a good track record in many parts of the world, with

A Microloan Program

Experience worldwide shows that the creation of new, growth-oriented businesses is not achievable by everyone. Yet a democratic society functions best when all persons are empowered to participate to the extent that their talents and ambitions allow. Indeed, small businesses healthy enough for an entrepreneur to support a family and perhaps one or two employees can make a valuable contribution to the economy and culture of the Island.

To stimulate such enterprises, a program of small loans for new businesses could be developed. This could spring from a modification of current government programs, or it could be a new initiative if funds permit. In either case, the central idea is to make small loans, perhaps with a ceiling of $20,000, available to small businesses. These would not be grants. They would be made in consonance with good business practices and with the expectation of a return of principal and interest.

To achieve this, the program must be administered by a private institution, not by the government. That would avoid the temptation to fund politically popular causes or groups, and even with the best of intentions, government officials are unlikely to be skilled business lenders. Government oversight is, of course, appropriate, since public funds would be used for the initial capitalization. Once capitalized, however, the funds could be replenished from the loan portfolio, and the lending mission might become self sustaining.

The microloan program should operate in close liaison with the other institutions for entrepreneurial support that would be developed on PEI, especially with those that mentor and train new entrepreneurs and with other, private investors.

microlending banks in places like Bangladesh claiming nearly one hundred per cent repayment rates. No worse should be expected in Canada. This would be principally a social equity program, but its popularity may help build support for a larger venture capital facility.

Other first stage financing facilities can be organized by the private sector. New ventures clubs can provide mentoring as well as finance, and associations of female entrepreneurs have been successful in promoting economic growth in other jurisdictions.

Having urged the government to facilitate start-up financing, we must note that a cultural characteristic cited by many participants, particularly from the private sector, was over-dependence on government. For new ventures on PEI, government serves as the gatekeeper, or financier of first resort. Even if a would-be entrepreneur does not need the money, he or she finds it advisable to approach government sources in order to get an imprimatur that will open doors to private funders. And, of course, it may be necessary to stake a claim and head off the possibility that a competitor will get the subsidy from government.

Where the good ideas are brought to government even before partners are sought, it is government that determines in large part what kinds of enterprise are supported and how they are run. Government and private investors have rather different approaches to a business. Government normally supports private business mainly in order to foster job creation; they would prefer a business with a larger payroll to one with a smaller. Private investors tend to have the opposite approach; they seek to minimize resources and think that the smaller the payroll the more productive the enterprise. Further, governments, like banks, tend to favor support for tangible capital equipment and to discount knowledge assets that can walk out the door. And there is a tendency to protect an investment from failure as only government has the power to do. These characteristics do not lead to the kind of lean, competitive productive sector that results in long-term growth and high-paying jobs.

We recommend that in the long term the government withdraw from direct involvement in private sector financing. In the short term, the proportion of successful applications for support can be reduced, and replaced in some cases with honorable mentions and referrals to private banks. The microfinancing or venture capital facilities with independent boards of directors proposed above are not inconsistent with this approach. Since they both require repayment or assumption of equity, they can generate revolving funds and be required to become independent and self-sustaining over the medium to long term, or they can be phased out, with the funds returned to the treasury.

POSTSCRIPT

We realize that many initiatives already have been taken. The government is not unaware of the challenges of the developing knowledge economy, and it has

responded with a number of valuable programs. Nonetheless, we observe that there is ferment and excitement in the technical and private sector communities, from the hands-on training effort of the community in Wellington to the sparks of initiative in the IT area to the organized developments of the producers' organizations in potatoes, swine, lobsters, and other commodities. Alert as the government is, it would seem to us that the private sector has the greater momentum. Participants in the activities of the Knowledge Assessment were knowledgeable about advances in their fields, realistic about the risks and opportunities, and prepared to take initiatives when given the opportunity to do so. One aim of governmental programs should be to encourage and open doors for the individual citizen, and to leave decisions and outcomes to their own perspicacity and fortune.

The process begun with the Knowledge Assessment was a useful one, beyond the findings of the present study. Several of the virtual case studies have resulted in deals, prospectuses, even recruitment of management teams, and some of the vanguard enterprises may one day become real enterprises. The process of gathering interested, informed, and energetic people in a structured exercise has proved catalytic, and in one form or another should be continued. This could one day become a function of the Center for the New Economy should it become a reality. The case study format is not the only way, but we also think that the presence of outsiders lends a fresh ingredient to the catalysis. We were happy to have the chance to help.

Appendices

APPENDIX 1

List of Participants

FOCUS GROUPS, FEBRUARY 24 AND 25, 1998

U.S. National Research Council Participants

David Bodde
Professor of Technology and Innovation
Henry W. Bloch School of Business and Public Administration
University of Missouri, Kansas City, Kansas

Michael Dow
Consultant, International Development
Chevy Chase, Maryland

Prince Edward Island Participants:

J.P. Arsenault
Policy Analyst
Department of Agriculture and Forestry
Government of Prince Edward Island

Brenda Brady
Head Librarian
Holland College

Janice Broderick
President, Student Union
University of Prince Edward Island

Bill Buell
Community Development Planner
Executive Council Office
Government of Prince Edward Island

John Burka
Professor, Department of Anatomy and Physiology
Atlantic Veterinary College
University of Prince Edward Island

Tim Carroll
Professor, School of Business
University of Prince Edward Island

Robert Coffin
Research Scientist
Cavendish Farms, PEI

David Cook
Adjunct Professor, Political Studies
University of Prince Edward Island

Aubrey Cormier
Founding Director, Centre Provincial de Formation pour Adultes
Wellington, PEI

John Crossley
Academic Vice President
University of Prince Edward Island

Richard Davies
Millery Farm, Flat River, PEI

Donald Deacon
Charlottetown, PEI

Kenneth DesRoches
Managing Partner, Matrix Consulting Group
Charlottetown, PEI

Ken Forse
Site General Manager
Allied Signal Aerospace Canada
Slemon Park, PEI

Anne Gillis
Consultant on Employment Services and Operational Systems Training
Human Resources Development Canada
Government of Canada

Ralph Grant
President
PEI Teachers Federation

Tom Hall
Consultant
Education Policy

Judith Holton
Vice-President and Program Manager
Primary Health Care Resources International Inc.

Wayne Hooper
CEO, AVC Inc.
University of Prince Edward Island

Dan Hughes
Vice-President for Human Resources
Cavendish Farms, PEI

Don Josey
President
Academy of Learning

Craig Levangie
Account Manager
Business Development Bank of Canada

Ron MacDougall
Integrated Solutions Manager
Island Tel Advanced Solutions

Bob MacGregor
Financial Analyst, Income Support
Agriculture and Forestry
Government of Prince Edward Island

Gary MacLeod
Co-owner, Sherwood Do-It Centre
Co-owner, Maynes Murphy & MacLeod Construction

Brian MacMillan
Director, Program Operations
Holland College

Bill MacPherson
Acting Director, Planning and Development
Holland College

Richard Martin
Program Leader
Crops and Livestock Research Centre
Agriculture and Agri-Food Canada
Government of Canada

Shawn McCarvill
President
PEI Capital Inc.

Vince McKenna
Vice President
Deltaware Systems Inc.

Sean McQuaid
Writer
Cardigan, PEI

Morley Pinsent
Rural Resource Consultant
Breadalbane, PEI

Don Rainnie
Senior Research Scientist
Atlantic Fish Health
University of Prince Edward Island

Geoff Ralling
Research Scientist and
Acting Director of Research and Development
University of Prince Edward Island

Ed Richard
IT Consultant, Elementary English Programs
Department of Education
Government of Prince Edward Island

Peter Rukavina
Owner/Operator
Digital Island Inc.

Lamont Sweet, MD
Chief Health Officer, Health and Social Services
Government of Prince Edward Island

Vianne Timmins
Dean of Education
University of Prince Edward Island

George Webster
Co-owner, Mid-Isle Farms
Potato farm operator
Bedeque, PEI

Andy Wells
Retired public servant
Hunter River, PEI

CHITIN CASE STUDY, APRIL 21-22, 1998

U.S. National Research Council Participant

Ray Pariser
Director and Vice President for Production
Marine Polymer Technologies Inc.
Belmont, Massachusetts

Prince Edward Island Participants

Richard Ablett
Executive Director
PEI Food Technology Centre

Alan Baker
Executive Director
Canadian Atlantic Lobster Promotion Association

John Bradley
Sales and Marketing Representative, Biochemical Division
Diagnostic Chemicals Ltd.

Jim Campbell
Learning Manager for Aquaculture
Ellerslie Aquaculture Facility
Holland College

Rick Cawthorn
Faculty
Pathology and Microbiology
Atlantic Veterinary College
University of Prince Edward Island

Lewie Creed
Assistant Deputy Minister, Fisheries and Environment
Government of Prince Edward Island

Roger Gordon
Dean of Science
University of Prince Edward Island

Shawn McCarvill
President
PEI Capital Inc.

Bruce Smith
Manager of the Wildlife Habitat Improvement Program
Fisheries and Environment
Government of Prince Edward Island

SWINE BREEDING CASE STUDY, APRIL 23-24, 1998

U.S. National Research Council Participants

John R. Dobrinsky
Research Physiologist
Agricultural Research Service
U.S. Department of Agriculture
Beltsville, Maryland

David Meeker
Associate Professor of Animal Sciences and
Coordinator of the Ohio Pork Industry Center
The Ohio State University
Columbus, Ohio

Prince Edward Island Participants

Allan Campbell
Research Engineer
Crops and Livestock Research Center
Agriculture and Agri-Food Canada
Government of Canada

Wayne Hooper
CEO, AVC Inc.
University of Prince Edward Island

Daniel Hurnik
Faculty
Health Management
Atlantic Veterinary College
University of Prince Edward Island

Paul Jenkins
Swine Specialist, Department of Agriculture and Forestry
Government of Prince Edward Island

Trevor Lank
Co-owner, hog operation
Cornwall, PEI

Lorraine MacAuley
Marketing Consultant
Charlottetown, PEI

Theodore VanLunen
Research Professor
Health Management
Atlantic Veterinary College
University of Prince Edward Island

E-COMMERCE CASE STUDY, MAY 9-10, 1998

U.S. National Research Council Participants

Chris Deephouse
Principal Engineer
CyberCash Inc.
Reston, Virginia

Phyllis Reuther
Graduate Research Associate
Carnegie Mellon University
Pittsburgh, Pennsylvania

Diane Wetherington
DRW Associates Inc.
Bellevue, Washington

Prince Edward Island Participants

Cam Beck
Coordinator, Small Business Center
Holland College

Nigel Cuthbertson
President
N. R. Computronics Ltd.

Bryson Guptill
Director, Corporate Partnerships
Department of Veterans Affairs
Government of Canada

Anthony Howarth
Multi-Media Designer
Information Technology in Education Center (ITEC)
University of Prince Edward Island

Des Lecky
Director of Technology
Department of Fisheries and Environment
Government of Prince Edward Island

Justin MacLeod
Partner
Timeless Technologies Inc.

Dale Mattock
Director
Information Technology in Education Center (ITEC)
University of Prince Edward Island

Carol Mayne
Director, Policy and Planning
Department of Economic Development and Tourism
Government of Prince Edward Island

Gary Stairs
Consultant, Communications and Development
Fredericton, New Brunswick

Ron Waite
Director of Business Development
Island Tel
President, Island Tel Advanced Solutions

WIND TURBINE MANUFACTURE CASE STUDY, MAY 11 - 12, 1998

U.S. National Research Council Participants

Jamie Chapman
President
OEM Development Corporation
Boston, Massachusetts

Andy Kruse
Co-founder and Vice President
Southwest Wind Power
Flagstaff, Arizona

Prince Edward Island Participants

Carl Brothers
Site Manager
Atlantic Wind Test Site
North Cape, PEI

Allan Brown
Industrial Technologist Advisor
Industrial Research Assistance Program
National Research Council of Canada
Holland College

Kirk Brown
Industrial Technologist Advisor
Industrial Research Assistance Program
National Research Council of Canada
Atlantic Veterinary College
University of Prince Edward Island

Ron Estabrooks
Energy Advisor, Energy and Minerals Section
Department of Economic Development and Tourism
Government of Prince Edward Island

Dan Fenety
Vice President for PEI
Atlantic Canada Opportunities Agency (ACOA)
Government of Canada

Malcolm Lodge
Consultant
Electrical Engineering and Wind Energy Systems

Peter Meincke
Professor, Physics Department
University of Prince Edward Island

Teresa Mellish
Planning Officer, Agriculture and Forestry
Government of Prince Edward Island

Gary O'Rielly
Manager of Engineering & Production
Maritime Electric Ltd.

Ali Syed
Testori Americas Corp.
Slemon Park, PEI

TELEMEDICINE CASE STUDY, MAY 14 - 15, 1998

U.S. National Research Council Participants

Douglas Perednia
Director
Telemedicine Research Center
President of the National Association of Telemedicine Providers
Portland, Oregon

Pam Whitten
Director, Information Technology Services and Research and
Assistant Professor, Department of Family Medicine
University of Kansas Medical Center
Kansas City, Kansas

Prince Edward Island Participants

Bernadette Allen
Founder and Principal
Future Learning Solutions Inc.

Mary Jane Callaghan
CEO, Eastern Kings Health Region
Government of Prince Edward Island

Glenda Dell
Professor, School of Nursing
University of Prince Edward Island

Judith Holton
Vice-President and Program Manager
Primary Health Care Resources International Inc.

Don Ling
Medical Director, Department of Health and Social Services
Government of Prince Edward Island

John Martin
Regional Director for Community Development
West Prince Health Region
Government of Prince Edward Island

Steve Murray
Manager, Information Networks
Island Tel

Mary Hughes Power
Director, Acute and Continuing Care
Department of Health and Social Services
Government of Prince Edward Island

Barry Stahlbaum
AphinNet Project Manager
Atlantic Veterinary College
University of Prince Edward Island

Dean Vokey
Learning Manager, Paramedicine
Holland College

Peter West
Analyst, Corporate Partnership Directorate
Department of Veterans Affairs
Government of Canada

APPENDIX

2

Chitin Production from Lobster and Crab Shells on PEI

INTRODUCTION

This virtual case study was carried out as part of the Knowledge Assessment Methodology Project in Prince Edward Island. As one element of the methodology, virtual case studies are used to explore the weaknesses and strengths of the existing knowledge economy, employing as a vehicle the planning of a hypothetical, knowledge-based enterprise in an area of comparative advantage that is affected by technical change. It is emphasized that this report is almost entirely drawn from the expertise and experience of the participants, and is not intended to propose that such an enterprise actually be established on PEI.

The virtual case study (VCS) on chitin production took place on the campus of the University of Prince Edward Island. Participants included representatives of the fishing industry, the Atlantic Veterinary College, the Food Technology Center, the Provincial Government, and the private sector. The U.S. National Research Council was represented by Ray Pariser, retired Professor at the Massachusetts Institute of Technology, and Michael Greene, Director of International Development Programs at NRC.

BACKGROUND

There are two kinds of polysaccharides common in nature, the cellulose, characteristic of the plant kingdom, and chitin, found in members of the animal kingdom. Together they are the most abundant organic materials in nature. One species of plankton alone produces 100 billion tons of chitin per year.

Technically, chitin is a polyanacetylglucosamine, characterized by the presence of a charged NH group and an acetyl group CH_3CO. In nature, no organism produces pure polyanacetylglucosamine, but all arthropods produce partially acetylated polysaccharides, often contaminated with heavy metals and amino acids. Some species of fungi also produce chitin. In practice, the term chitin has come to mean generically the material that is produced in nature, rather than the pure molecule. The processed form, in which the deacetylation is between 30 and 70 per cent, is called chitosan. Chitin is insoluble in water and must be dissolved in acid; chitosan is water-soluble.

Aside from its structural function in arthropods, chitin plays other important roles in nature. It contributes to keeping the oceans clean. The chitin released by the shells of molting organisms falls to the sea bed where it forms a powerful chelating agent, attracting heavy metals, especially transition metals, and providing nuclei for the manganese nodules found on the ocean floor. At the other end of the spectrum, chitin is metabolized by the human body to produce glucose, and it has been adopted by advocates as a nutraceutical dietary supplement. Rats have been said to starve after eating chitosan because it absorbs nutrients and bacteria that participate in digestion as it passes through the gut. It is used in weight loss remedies on the market but may be dangerous.

The composition of harvested chitin is highly variable, even from a single source like lobsters. The amount of metal and amino acid contaminants will depend on water quality and on diet, and they can be quite difficult to remove. The industrial production of pharmaceutical or biomedical quality (i.e., pure) chitin from natural chitin may not yet have been realized successfully.

Shellfish wastes have a water content equal to two-thirds of the total. As such, the 15 million pounds of resource available in or near PEI would yield five million pounds of dry shell. This shell can be assumed to be about half mineral matter (mostly calcium carbonate), one-quarter protein suitable for use in animal feeds, and one-quarter chitin, as well as small quantities (one per cent or so) lipids, and a tiny quantity of very valuable red dye, xantheum. As such, the shell resource on PEI could yield up to 1.25 million pounds annually of chitin, as well as several by-products. PEI's situation may be highly advantageous, because its small size and the proximity of its shellfish processing operations facilitate storage and handling of the shells, which deteriorate within hours.

Historically, applications have included wastewater treatment, use for recovery of protein from egg wastes for animal feed, wound healing, crop protection (from fungi), glue, and color photography. The problem in higher end applications is consistency of the feed stock; every batch must be tested.

Unfortunately, there is probably no viable industry experience to draw on in this virtual case study. Some of the largest producers overseas produce chitin of unreliable quality. Those seeking to attain higher quality product have not been profitable, in part because of the problem of collection and preservation of raw material.

THE ENTERPRISE

In view of the above considerations, in our virtual case study we examine the opportunities for a company with the following characteristics.

Statement of Purpose

The enterprise will utilize waste products from PEI's lobster and crab fisheries for value-added wealth creation.

What is the product?

The company will extract raw chitin, raw protein, and raw lipids from shells, and prepare refined derivatives of these. The objective will be to produce high grade, reliable, quality controlled product.

The list of possible applications is long, and includes water treatment, seed coating for protection from fungi, hair products, surgical sutures, fruit and vegetable preservatives, fungicide, contact lenses, animal feed, cholesterol or fat reduction, fiber additive, and basal material for sustained drug release.

Who are the customers?

The potential market includes industrial, food, nutraceutical, pharmaceutical, and biomedical applications.

Who are the competitors?

A facility in New Brunswick provides chitin currently used in DuPont's paper plant (a low-end application), with plans to expand into food-related uses, and a facility being planned in Iceland focuses on flavorings and dyes. The Japanese currently produce large quantities of chitin using a decades-old technology, but the quality is too poor for anything other than low-end uses not requiring high purity. A Norwegian plant located in Washington State has recently closed, ostensibly for environmental reasons. And, closer to home, there is an application to ACOA and Enterprise PEI by a consortium from Alaska and Quebec to build a chitin plant in PEI based on new technology developed at Laval University in Quebec for which a patent has been applied; unfortunately, little was known about this technology by the participants in the virtual case study.

What resources will be used?

The feedstock will be lobster and crab shells from PEI. The potential resource currently amounts to about 4 million pounds of lobster shells and 8 million

pounds of crab shells annually. The possibility exists to access perhaps another 4 or 5 million pounds from within 50 miles on the mainland. More may be available if the chitin market proves lucrative; about 70 per cent of the lobster harvest is prepared for in-shell presentation and the shell is lost for reuse. If the value were high, this ratio might change.

What technologies will be used?

For the purposes of the VCS, existing, non-proprietary technologies will be assumed. The Quebec technology is claimed to have the potential to produce a higher-quality, consistent product, and is currently in the small-scale demonstration phase. This technology will be considered as well, to the extent possible. However, at present there are no existing successful chitin processing plants based on lobster; the commercial processes are generally designed for shrimp or crab, and the lobster-derived product must be tested to assure process efficiency and product quality.

The elements of the basic process are:

1. harvest, clean, and separate shells mechanically;
2. pre-treat—grinding and ensiling—to prepare and preserve feedstock;
3. remove proteins to give chitin-mineral complex;
4. remove minerals to yield chitin;
5. deacetylate to make chitosan;
6. finish.

What is the core competency that gives a competitive edge?

The resource of crustacean shells is substantial and more concentrated in location than anywhere else in the world.

RESOURCE AVAILABILITY

A recent survey has identified 10 million pounds of shell currently discarded annually by Island lobster and crab processing operations. Fifty per cent of lobster wastes are produced in the two months of May and June. Other active periods are fall and winter for crabs and August and September for lobsters. This offers two alternatives: a plant capable of processing the peak amounts of material in two months, and remaining idle for much of the year, or a plant designed for average capacity, complemented by facilities to store and preserve the shell material. Economics will probably dictate the latter solution. The slurried feedstock will be continuously collected and brought to a central location for processing.

To prevent deterioration, ground lobster and crab shells can be dried, frozen, or ensiled in an alkaline environment (acids will dissolve the shell). Drying re-

quires expensive energy, and water will be readded during the manufacturing process. Freezing takes energy and cold storage facilities, so ensilage is probably preferable. The grinding can be done in an alkaline environment to reduce odor. Grinding and storage facilities can be placed adjacent to each processing plant. Rubber or glass-lined tanks are manufactured in PEI and can be readily obtained. pH must be continuously monitored and controlled during storage. However, the actual condition and stability of the material during storage in an alkaline environment are unknown, and should be investigated.

A key consideration for the long-term success of the enterprise is the sustainability of the PEI lobster and crab fishery. The fishery has been stable for over a century, and the Canadian management plan predicts continued adequate numbers of catch. The lobster harvest is presently running at 2.5 times the thirty-year average, in part because of improved technology. Crab stocks are good, and the catch has risen in the short term because of high prices.

There are three local candidate species for the chitin industry: lobsters, rock crab, and snow crab. Currently, snow crab is mostly sold in the shell, so the shells are hard to collect. Spider crab is also available, but it is not utilized because of a thick shell and limited meat content. It may be economic to harvest spider crabs specifically for the chitin industry, but fishing a species for non-food uses is considered in some quarters unethical.

PRODUCTION REQUIREMENTS

There are now 12 lobster processing plants on the Island. One of them could be expanded to embrace a central chitin manufacturing plant, but it may not be feasible or safe to locate the central plant near where food is processed. More appropriate would be association with an industrial chemical plant or wastewater treatment plant. The effluent from the chitin plant will need to be treated to protect the environment, so an existing plant that presently dilutes acid and alkaline effluent would be advantageous.

Operation and maintenance of the plant would require a manager with a technical background, a plant engineer, technicians to perform tests for quality control, and scientists to carry out research and development to maintain and improve the operation. There are capable people working in PEI now, and new recruits can probably be found here or in the other Maritimes. The workforce could include seasonal fishermen and thus help to sustain the industry. High level technical advisors can be brought in from elsewhere when needed.

All required equipment can be bought off the shelf, and much of it is available in PEI. Another alternative is to obtain equipment from firms that have gone out of business, when they can be located. The now defunct Norwegian plant in Washington may provide such an opportunity.

A subcontractor may be required to provide transport for collecting the raw material from the storage areas adjacent to the processing plants and bringing it to

the central plant on a continuous basis. This will require 1-3 trucks to collect slurry, and this could be a significant cost.

Raw material could either be obtained on contract or by including the processors as co-owners of the plant. Contracting for the raw feedstock might leave the company vulnerable to price rises or to loss of the supply to a competitor (or to the same processors, going into the chitin business for themselves if it is successful).

Laboratory analysis of the product and byproducts for quality control will have to be done in the plant or on the island. There are several laboratories on the island, both public and private, that could assist. Sterilization, if needed for biomedical products, could be contracted to Queen Elizabeth's Hospital in Charlottetown.

The quality factors are: solubility; viscosity; molecular weight; degree of deacetylation, or free amine content; moisture content; protein content; ash content; lipid content; and optical activity. Other tests for special applications are: amino acid profile; trace metal analysis; fatty acid profile; thermal stability; metal adsorption; crystallinity; antigenicity; and pyrogenicity. All except amino acid profile and crystallinity can be done on the Island, and those two can probably be done in Halifax.

The enterprise will produce crude, medium, and high quality product for different markets. The company may wish to start with the crude product and negotiate contracts at a low price, then form joint ventures as it moves into higher end product. The low-end material will be shipped by the ton, and can be carried by truck in 50 pounds bags. At the high end, grams of product will be shipped by express mail. For quality chitin or chitosan, sterile containers may be required.

In the effluent, acids and alkalines can be neutralized. The neutral product will contain acetates and calcium chloride, which could be spread on roads for de-icing as a less corroding substitute for salt; it can also be applied in summer to moisturize roads and dampen dust. Using a solvent extraction process, a red dye can be obtained which is used to color salmon. If oil, obtainable from the French fried potato plants, is used as solvent, the oil containing the dye can be fed directly to the fish. The products, dye for salmon, protein feed supplement, road treatments, and possibly soap from the lipids, will leave little effluent to dispose of.

Environmental concerns can also be tempered by the fact that the 50 per cent biomass residue of the $100 million lobster industry will be upgraded and used, leaving little residue. Presently most of the shell from the processing plants is spread on farmers' fields, at some cost to the lobster producers, and with some environmental impacts related to odor if the shells are not quickly incorporated into the soil.

Certain questions still must be explored before a chitin proposal can be assessed. A pilot plant scale research project will be necessary before a plant can be designed and costs can be estimated. Among the questions to be answered are:

- Can the ground shell from the processing plants be stabilized in an alkaline environment? What is the effect on the material of ensilage and prolonged storage? Is preservation and storage throughout the year more efficient than bulk processing during part of the year?
- Which technology would be most efficient? Several alternatives should be tested, including the Quebec technology.
- What is the variation of shell composition, by species, season, and harvest? How do the compositions of the shells of lobster, shrimp, and the several crab species differ? Should lobster and crab wastes be stored in separate tanks?
- Can the byproducts be made cost-effectively? Can byproduct output be effectively adjusted and linked to variation in shell composition?
- What is the potential supply of lobster, crab, and shrimp, by month of the year?

Unfortunately there is no graduate program at UPEI or Holland College related to chitin research, so the research program can not easily be used to train the next generation of experts in this field. A graduate program in biochemistry could train a generation of scientists specializing in marine products that could benefit all of Atlantic Canada, and a chitin plant would provide a good opportunity for cooperative training.

LEGAL AND REGULATORY REQUIREMENTS

A permit would be required to operate the plant; this can be obtained with a one-month turnaround following submission of an environmental impact statement for the plant and the effluent and solid material. The data from the pilot plant project could provide the basis for the EIS. A building permit, likewise tied to the environmental statement, would also be needed. Before a food product can be marketed and sold, the Food and Drug Administration will inspect the plant.

In order to export to the United States, European Union or Japan, good manufacturing practices (GMP) and good laboratory practices (GLP) must be certified, in addition to passing the FDA inspection. These are the responsibility of the National Institute of Standards and Technology and FDA, respectively, for the United States. Europe has similar arrangements, but Japanese certification is somewhat more complex.

MARKETING REQUIREMENTS

There is a solid, but low end, demand for chitin related to water purification, at about $10 per pound, and promising opportunities in food supplements. High-end biomedical uses may draw around $2,000 per pound, and there is a broad range in between. It is also possible that the plant can be used for other marine extraction products, like seaweed and jellyfish. For most other potential applica-

tions of chitin or derivatives there is presently no market, in part at least because there is no supply. There are only about three major chitin plants in the world: in Japan, Washington (now closed), and Norway. New plants are opening in India and China. Research on applications may provide important tools for marketing, aside from the prospect of spin-off industries.

IMPLEMENTATION PLAN

The Alaskan-Quebec consortium has estimated $5 million to build a plant in PEI, using their own technology, and is looking for a 50 per cent partner. The storage tanks would cost additional. A local consortium to partner with the Alaskan-Quebec group may be a valid solution, and there is much venture capital in PEI looking for projects. Alternatively, the local group can lease the Quebec technology and test it in a pilot plant. If it is economical and successful, they could try to buy or license it.

The lobster processors have a natural interest. The Food Technology Center might also take a share; it is now able to enter an arrangement with a private partner. If there is a promise of many jobs, the government might contribute; if promise of profit, the venture capitalists. One venture capital fund, for example, has $30 million to invest in Atlantic Canada. There are also Federal funds available to support science and technology initiatives, which might support the pilot project. Even DuPont has components that provide venture capital.

The processing community is not likely to take the initiative but might be persuaded to join a developing venture. A manager should be sought, a technical person with knowledge of marketing and procurement. At an early stage he or she should approach the processors to engage them as partners; this is crucial to avoid major problems with supply or competition later on. Following a recent restructuring of the industry, there are presently seven independent suppliers on the Island; the largest of these, Polar Foods, controls about 50-60 per cent of the shells. As a partner, Polar Foods alone could guarantee an adequate supply.

Probably the most immediate need is for funding to cover the cost of the pilot plant R&D program. As generic research that could benefit an entire industry, it might qualify for government funding. If the Quebec technology does not work out, there are other, unpatented technologies that might be adapted successfully to process the material available on PEI. An advantage of this course would be that the expertise thus developed could be licensed to other areas of high shell supply, such as Central America. In the longer term, this expertise could be expanded to include systems knowledge related to resource management, feedstock storage and transport, and marketing, as well as the processing technology itself. Chitin processing would thus become the basis not only for a new export product, but also a highly exportable knowledge-based service.

APPENDIX
3

Swine Genetics on PEI

INTRODUCTION

This virtual case study was carried out as part of the Knowledge Assessment Methodology Project in Prince Edward Island. As one element of the methodology, virtual case studies are used to explore the weaknesses and strengths of the knowledge economy, employing as a vehicle the planning of a hypothetical, knowledge-based enterprise in an area of comparative advantage that is affected by technical change. It is emphasized that this report is almost entirely drawn from the expertise and experience of the participants, and is not intended to propose that such an enterprise actually be established on PEI.

The virtual case study was conducted on the campus of the University of Prince Edward Island on April 24, 1998. Participants included representatives of the pork industry, the Atlantic Veterinary College (AVC), the Hog Commodity Marketing Board, The Crops and Livestock Research Centre of Agriculture Canada, the Provincial Government, and other professionals from the private sector. The U.S. National Research Council was represented by Dr. David Meeker, Coordinator of the Ohio Pork Industry Center and Associate Professor of Animal Sciences, The Ohio State University; Dr. John Dobrinsky, Research Physiologist, Embryology and Cryobiology, Germplasm and Gamete Physiology Laboratory, U.S. Department of Agriculture, Beltsville, MD; and Dr. Michael Greene, Director of International Development Programs, National Research Council.

BACKGROUND

Pork production is a $31 million industry in Prince Edward Island, producing about 200,000 animals per year. It is comprised of about 250 producers, highly organized, who cooperatively own PEI Quality Swine Co., which produces breeding females in two low-disease facilities for all producers on the Island. The disease burden is relatively low; the Island appears to be free of Transmissible Gastroenteritis (TGE) and has a prevalence rate of about 33 per cent of farms infected with Porcine Reproductive and Respiratory Syndrome (PRRS). These two viral diseases are common in North America, and have major negative consequences in other regions.

Further, PEI is an island with limited routes of access from the mainland, and there is the possibility of establishing a low-disease, biosecure zone for pork production. Such a status would make PEI highly competitive as a source of low-disease breeding stock, and would enable PEI to be a repository for special genotypes. For example, pigs may be used in the future for research purposes in such human xenotransplant applications as embryo brain tissue for Alzheimer's patients. These applications require expensive, highly inbred populations, which reproduce poorly, and are therefore vulnerable to loss. A biosecure island would also enable the preservation of genetic diversity of pigs, by preserving in culture samples of populations of pigs in areas subject to decimation by disease and enable the regeneration of these herds in a low-disease condition. The development of genetic engineering and embryo transplant technologies on the Island would also expedite shipping of germ plasm and even permit the production of designer pigs for a specialty or niche market.

THE ENTERPRISE

The virtual case study will describe a company called "Island Genetics" with the following characteristics:

Statement of Purpose

The enterprise will build on PEI's strengths in biosecurity, in industry organization and structure, and its current capability to produce low-disease animals, in order to export low-disease breeding stock to international markets.

What is the product or service?

The main product would be high quality 21 day old F-1 breeding females shipped live, to be used as parent breeding stock when they are about 8 months old. Longer term opportunities include: embryos, semen, and fertilized eggs; a repository of rare, valuable varieties of hog such as those used in medical re-

search; and genetic rescue and repopulating of hogs from countries affected by disease.

Who are the customers?

The customers for the live breeding stock would be large pork producers in North America.

Who are the competitors?

The competitors are major suppliers of breeding stock breeding females in the United States, such as Pig Improvement Company (PIC).

What technologies will be used?

Initially, technologies will be those presently utilized by the biosecure production facilities on the Island, expanded to include a larger number of producers. Ultimately the biosecurity of PEI will lessen the need for all producers to maintain strict biosecurity. At that time, genetic engineering, sperm sexing, and embryo preservation and transplant technologies, presently in the experimental stage, will be introduced and utilized.

What is the core competency that gives a competitive edge?

PEI is a relatively small island suited to mixed agricultural production, with an organizational and jurisdictional capacity to achieve and retain low-disease status. The producer community presently owns two low-disease breeding facilities that supply the Island's pig producers. The existing foundation herd consists of 200 sows. Increasing this base to 2,000 nucleus sows would form a genetic base equal to that of any swine company in the world. Island Genetics, as proposed, could involve existing PEI producers, as well as new producers, to increase the size of the nucleus herd to supply low-disease breeding stock for export.

BIOSECURITY

Presently there is no control of live animals entering the Island by bridge or ferry. However, there are draft regulations under discussion by the government that would considerably aid the effort to control disease in swine. The draft legislation in its present form contemplates using weigh stations at the ferry and bridge to check the health permits of pigs coming into the province by vehicle. Market hogs would require certifications of health, and those passing would receive a permit from the Department of Agriculture to go directly to the slaughterhouse.

Semen would also have to be monitored at the source and upon arrival, but as yet there is no provision to police this nor to analyze the incoming semen. The draft regulations do not include embryos.

A 1996 survey commissioned by the producer-owned PEI Hog Commodity Marketing Board found no TGE on the Island. The reported prevalence of PRRS, while low by international standards, still shows that a third of hog farms on the Island are infected. PRRS has an economic cost to the swine producer because it lowers growth rates and reproductive performance, and there is ample motivation on the part of the producers to eradicate it. Since PRRS is the most prevalent of swine diseases, eradication and monitoring of PRRS would go a long way toward eradication of all swine disease. PEI Quality Swine, the low-disease breeding arm of the Hog Commission Marketing Board, is at work on a strategic plan; the key issues are to balance restrictions on imports against free trade requirements and swine health regulations against freedom from compulsion.

Logistically, it is not a simple matter to clean up the herds. Farmers must sell all animals at once, then wash and disinfect the pens and buildings. They must fill the pens only with clean animals from a reliable source. It is time consuming, and many farmers can not sustain the interruption in cash flow. Leasing additional facilities that may be used by several farms can speed up the process. One biosecure facility is used for breeding low-disease stock. New herds are raised in second facilities while the original pens are being cleaned. In the best case, there need be no cash flow interruption, because the new clean herds grow faster than the old herds. But the cleanout must be carried out in summer for heat to enable complete cleanup and dryout, and it must be monitored. Until the entire island is biosecure there will be risk of reinfection, including mycoplasma pneumonia, which is a highly contagious respiratory disease. The entire process must be assisted and monitored by qualified practitioners, who can be trained by the AVC.

To fully capitalize on the low-disease status when it is achieved, production should be increased, both among existing producers and by expansion. The slaughterhouse is presently underutilized, and could sustain a substantial increase in throughput. The Island is self-sufficient in feed, and larger herds than at present can be supported. The feed is a soybean-barley mix. The barley is produced on PEI in rotation with potatoes and is available, but additional soy may have to be imported. With advances in swine nutrition, feed additives also may be effective. The additional manure produced by the larger herd can be used on the potato and expanded barley crops.

The major obstacle to expansion of the swine herd is the human population density. There are few places to create new units because of the separation required from both people and other pigs. However if pigs are shipped at 21 days, the new facilities will make a more moderate impact on the environment then would a comparable increase in hog production for meat. Many pig farmers are approaching retirement, especially in Queens County. Usually an old site already

enjoys neighbor tolerance, and these sites can be used and expanded, using new technology.

Some research is required to determine the composition of the new seed stock, comparing PEI swine against other breeds. It may be advantageous to buy or enter into an agreement with a breeding company off the Island to develop the capacity to work with other breeds; existing healthy PEI sows can be used to propagate the lines.

Eventually, import of live pigs should be prohibited. In general, free trade agreements require a tolerance, but if the Island is demonstrably PRRS-free, then restrictions relative to that disease could be justified. A list of known diseases should be drawn up, and a strategic plan developed to eliminate each one explicitly so as to eventually prevent nearly all importation, although there should be exclusions for research purposes and for candidates for "genetic rescue." (It may be politically impossible to proclaim disease-free status and prevent all importation, and the practical target may be "low-disease" with rigorous inspection and control of imports.) There are international guidelines for transport of embryos and sperm. Semen can be tested at AVC. It is not feasible to test embryos because the testing is destructive and the embryos are too valuable; the source herds have to be tested.

PRODUCTION REQUIREMENTS

Facilities and Siting

Facilities can be established by starting with existing infrastructure, by expansion of existing farms, or creating new structures and sites. Two thousand sows would be required in order to be globally competitive and limit the risk of inbreeding, but they can (and should) be housed on several different sites. Two thousand sows generate 20,000 pure line breeding females per year. About 6,000 can be selected as of very high genetic status. If we assume a 50 per cent replacement rate annually, 1,000 of these can be used for replacements in the nucleus herd, and 5,000 will be used to maintain a multiplier herd of 10,000 sows. This is roughly the size of the existing herd (approximately 10,000), so that up to a 100 per cent increase is needed. Ten thousand pure line sows would produce a total of approximately 200,000 F-1 hybrid pigs per year, of which nearly 100,000 could be sold at 21 days as potential parent stock. This could be done with a 50 per cent growth by current producers and 50 per cent by new installations.

There is a national data base maintained in Ottawa of all pure bred pigs. Semen can be selected from boars all over Canada, and sows can be selected from the best grandparents in Canada. But a private company may choose to stay out of the pool in order to protect proprietary genetic stock. In that case it must be self-sustaining, and the stock must be large enough to contain its own genetic diversity. That will require at least four different lines within the 2,000 sows. More

may be needed to service a niche market and to provide high technology services for the biomedical and other specialty markets. For the commodity market, high health F-1s must be competitive on quality and cost.

The 2,000 pig facility can be sited in three locations. That would require three nucleus barns plus 15 multiplication sites. Some of the existing producer operations could become multipliers. In all about 12 additional facilities might be required across the Island. Existing producers can finish those males and unselected females not sold at 21 days.

Subcontractors and Suppliers

Construction and electrical contractors on the Island are adequate. The feed can be procured locally. The equipment required can also be obtained from suppliers on the Island. The AVC can provide the training necessary for staff and producers.

The genetic testing technologies must be licensed, and people must be trained to use them. Alternatively, AVC could be contracted to carry out the necessary quality assurance testing. It could be done under an ISO 9000 regime, after bringing a consultant, perhaps from Denmark, to certify the processes. Once achieved, the system itself can be exported as an additional high technology service.

Distribution and Shipping

Live 21-day breeding females will be shipped, and the technology is well established. They can be trucked over the Confederation Bridge and flown out though the large airport at Halifax, or they can go by truck all the way to Chicago or even Mexico, using rigs with food and water aboard. Shipping batches of 200-250 21-day old pigs requires specialized trucks with feed, water, and air conditioning. Alternatively, a specialized container can be designed that can be shipped by truck or plane. Such containers may already be available in Quebec, and the loads only need be trucked that far. If 14-day-old breeding females are shipped, loads can be as large as 500-800.

Human Resources

At the head of the company must be someone who knows the industry and knows the markets. In the genetics industry, the technology and the quality control are so fundamental that often the CEO makes the technical decisions. The CEO may have to visit potential clients, with a veterinarian along to talk with technicians.

There must be a staff vet or a contract with the AVC. The selection of stock requires knowledge of genetics. Decisions must be made in each generation, including selection of sperm to accommodate changing market preferences. For the

niche market, monitoring biosecurity, or biopreservation of foreign herds, a full time equivalent service will be required. It might be useful to hire an internationally known geneticist as a consultant.

Current producers who elect to join the company will need training, and company staff will need continuous training and updating. The provincial government and the university have adequate training facilities, and it should be supplemented by periodic attendance at conferences across North America. Training should be done on the basis of a company operations manual, which could be prepared in partnership with the university.

Marketing and Market Research

For high quality product, it is advantageous to rely on skilled agents instead of using mass marketing strategies. The company should have a good marketing expert, who may be the CEO. High quality replacement breeding females are almost a commodity, but the competition focuses on value. Generic advertising is not useful in this market, but selling is done on a one-on-one basis. One hundred thousand breeding females a year can be sold to just five customers for about US$20 million, provided that the customers are kept happy. This requires a very specialized person.

The government could assist by paying part of the cost of the marketing person, or, more generally, by including the marketer in trade missions and other activities of Agriculture Canada, which is known for its aggressive and imaginative marketing. Alternatively, the company could form a marketing alliance with another company. For example, a swine feed or equipment company could become a dealer for PEI females, or a U.S. genetics company could increase its product line.

Before the specialty market is fully developed, the pigs can be grown out as market pigs and sold in the ordinary swine market on a break-even basis. However, the profit of the company will come from sales of breeding stock, net of the costs of testing, research, and marketing.

Research and Development

Sexing of sperm is still experimental; the patent is owned by USDA and eventually can be licensed. Such a technology could increase the percentage of offspring eligible to become female parents, and increase products for sale without increasing infrastructure. Presently the sexing procedure damages the sperm to the extent that they can not be frozen. Embryo transplant is presently performed surgically. Embryos can be sorted by sex in batches. Embryos can be easily and cheaply shipped in nitrogen in a cryovessel by plane, with almost indefinite lifetime. A non-cryopreserved specimen lasts for 48 hours, and boar semen one week. Federal Express can send four day embryos in culture without

freezing and transferred directly into sows, so there is no need for long term preservation. PEI should aim for state-of-the-art technologies, which are currently changing rapidly.

Once the high technology applications are established, a research facility will be necessary, either within the company or on contract. Semen sexing requires highly trained personnel and is very expensive; the equipment itself would cost upwards of $100,000. DNA testing would also require new equipment. These services can be outsourced to the veterinary college at Guelph University, Ontario, initially if resources are not available locally. AVC can assist as well, and it also has an unused laboratory facility that could be dedicated to the embryo transfer operations.

The record of performance (ROP) product testing can be done on-site, either by checking the males left behind for weight gain or by agreement with buyers to provide the data. Blood tests and DNA tests can initially be outsourced to AVC. Depending on the marketing agreement, it may not be necessary to test every animal, and lot quality assurance sampling can be done instead. This would be explored more thoroughly during the ISO certification process.

LEGAL AND REGULATORY REQUIREMENTS

Licenses

Island Genetics would require a license from the Hog Board, which it could obtain without a problem. There is no general license to export swine, but each individual pig must be inspected before shipment. It is tested for disease, including leptospirosis and brucellosis. A fee of $15 per pig is charged for the inspection.

Use of the technologies for sperm sexing will require a patent license from USDA. The embryo preservation techniques at present do not require a fee (but neither are they ready for commercialization).

A minor expense will be membership in the purebred breeding association. The genetic testing for the national gene pool along with the record of performance will cost more, if the company decides to participate. The Hog Board is also about to launch a Pork Quality Assurance procedure for certification based on food safety product quality. It requires a record of feed, medications, vaccination, etc. If the company exports to Europe or Japan, it will need ISO 9000-type certification. All these assurances will contribute to consumer confidence in the product.

Environmental Issues

The Departments of Agriculture and the Environment are in the process of redrafting the siting and environmental regulations for hog production, with

guidelines for management of manure and odor management. These deal with construction and siting of storage facilities and housing, and with the responsibilities toward the community. There are also guidelines for odor management. An environmental impact statement is required before construction, and there are requirements in the regulations for public consultation. There is a history of bad experience and bad feelings between hog producers and the community, and regardless of the guidelines, it will be necessary for each producer to deal personally with neighbors. On the other hand, the guidelines provide that the public will not be able to stop construction of the facility if all requirements are obeyed. There is also a Farm Practices Act before the legislature, which will discourage nuisance complaints by the public against legitimate farming activities. Nevertheless, it would be good practice to carry out tests before and after operation commences to monitor odor and water quality. In general, these regulations are supportive of the formation of high technology production units like Island Genetics.

Insurance required includes the usual liability, fire, and workers' compensation. There should also be insurance against damage to pigs, for example, if the power fails, so that an accident does not wipe out all assets. Product liability insurance on the health of the pigs is expensive but optional. An alternative would be to sell breeding stock "as is" and ask customers to quarantine the breeding stock for 30 to 90 days; it will be necessary to explore whether customers would accept that, or whether such disclaimers would undermine the marketing strategy.

IMPLEMENTATION PLAN

Estimated Start-up Costs

Industry-standard data is available on customary construction and service costs. For the high technology part, some aspects are not yet on the market, and therefore it is difficult to assess the costs. For the 21-day breeding females, no separate nursery is required, and building and manure storage costs are estimated at C$1500 per sow for gestation to farrow facilities. The breeding stock itself would be about C$2500 per sow.

Stakeholders

The enterprise could be producer-owned or funded by venture capital. Possibly the leadership would come from local producers, who would prepare a basic plan for approach to venture capital, seeking about $5 million for the nucleus herd. There is a precedent on PEI in the case of a consortium of producers who raised money for a potato dehydration plant. The hog producers are linked already through their participation in the PEI Hog Commodity Marketing Board,

which owns the present Quality Swine nucleus units. There are also a PEI Swine Breeders Association and a Quality Swine Multipliers Association, and all producers belong to one or more of these organizations. If the associations were involved, then all producers would have a stake. The processing plant will also be a stakeholder, one way or the other. Sales of 21-day breeding females may reduce the number of pigs sent to the plant, and this may raise concerns about the viability of the plant, which is presently operating below capacity. Alternatively the increased number of males may increase its business. The plant is being subsidized by the Provincial Government and by the producers; the government values the prosperity of the pork industry, but it may be concerned about any development that might hurt the plant.

Source of Financing

There is an immigrant investor fund in Canada, which provides loans at low rates for Canadian enterprises like this one. There is also private venture capital available. There is a small fund available to Enterprise PEI from Garden Province Meats, the operator of the processing plant, intended for expansion of the pork industry and increased input to the plant. Island Genetics may qualify if the increased number of males generates a net increase.

If the producers are involved as stakeholders and investors, they can go to the bank themselves and borrow with no additional security required beyond the stock and facilities. That would give the producers their equity stake and a share in the benefits.

Management

The enterprise could be started by a team put together by the producers, but before long it will be necessary to hire a professional manager with marketing skills as described above. There already may be such people on the Island.

Biosecurity

The key to success of this enterprise will be creation and maintenance of the low-disease herd, and that will require positive actions to increase the biosecurity of the Island. There is at present no impediment to importing or raising diseased pigs on PEI. The proposed new regulations will create buffer zones for new facilities and make it more difficult to import pigs, but nothing will prevent existing producers from raising diseased pigs. In order to become competitive in the swine breeder market, it will be necessary for the whole island to maintain the same standard. The government will not be able to pressure a determined minority to conform, so the pressure must come from the producer community. As older farmers leave the industry, their stock can be replaced with low-disease pigs, and

government and industry together can provide incentives or try to buy out the recalcitrant.

To restore a diseased facility quickly, additional subsidiary facilities will be needed, as described above, and the Hog Board can make these available. The changeovers must be done in summer, and it will take perhaps five years. Producers can help each other by providing low-disease breeding females.

Even after the Island herd is low-disease, a system must be put in place to keep it that way. Accidents will happen, and herds that are reinfected must be isolated. There should be segregated production in one place as insurance to protect against having to reconstitute the entire herd. The pigs must be constantly tested, including against diseases that are not known to be present in PEI. Often there will be false positives, and the alarm this causes must be prepared for.

A first step is to implement the strategy to eliminate PRRS within 6 months; that would reduce or eliminate many other diseases at the same time. (Elimination of PRRS will not necessarily help in the U.S. market, because prevalence there is over 90 per cent and the imported breeding females will get infected anyhow, unless producers want to vaccinate them. However the vaccine is a live attenuated virus, and creates sero-positive status in the pig. The producer gains economically from raising pigs free of PRRS that grow more rapidly, but the pigs have no intrinsic value as certified low-disease animals.)

At the same time, producers should actively encourage the Provincial Government to strengthen and implement the proposed biosecurity law that will restrict entry of pigs to PEI. Both as a disease prevention tool and as a marketing tool, passage of this legislation is the most important factor for the success of modern, high technology swine genetics on Prince Edward Island.

ADDENDUM

In July 1998, the Institute of Medicine and the Board on Agriculture of the National Research Council published, *The Use of Drugs in Food Animals: Benefits and Risks,* which contains the following section on biosecurity.[4]

THE USE OF DRUGS IN FOOD ANIMALS

Biosecurity

> Biosecurity techniques should be based on an understanding of pathogen transmission. Knowledge of all potential entry routes for pathogens to a herd is an essential prelude to developing a comprehensive biosecurity program. If multiple pathogens having different routes of transmission are listed according to priority for exclusion from a group of animals, a multi-point biosecurity program is warranted. Dial et al. (1992) summarized several sources in formulating

[4]*The Use of Drugs in Food Animals: Benefits and Risks*, National Academy Press (1999), P. 197.

biosecurity policies for swine, and these have application for all food animal species.

These biosecurity policies include:

- Locating the herd away from potential sources of infection, including other production facilities, slaughterhouses, sale barns, and roadways.
- Enclosing the herd in bird-proof facilities.
- Placing fences around the farm boundary and placing locks on doors and windows to prevent entry of visitors.
- Prohibiting entry of vehicles used to transport animals, unless they are empty and have been cleaned and disinfected before arrival at the facility.
- Providing secure loading areas that prevent animals from returning to the building once they have been exposed to trucks.
- Aggressively controlling rodent and fly populations, including the use of weed control and gravel borders to discourage rodents from approaching the facility.
- Excluding cats and dogs from the farm complex.
- Excluding all people, including visitors, who are nonessential to a farm's operations.
- Ensuring that farm personnel do not come in contact with animals outside the herd.
- Establishing a minimum quarantine time for incoming people before they come in contact with livestock.
- Requiring all people to shower before entering the farm and providing clothing to wear on the farm.
- Ensuring pathogen-free feed sources and instituting methods of delivering feed to the farm that closely control the access of potentially contaminated trucks.
- Cleaning outside feed spills to avoid attracting rodents and birds.
- Providing secure manure storage and disposal.
- Promptly disposing of dead animals.
- Moving incoming stock into an isolation area that has separate ventilation and manure removal systems.
- Placing sentinel animals with incoming stock and using diagnostic tests (for example serological tests or postmortem examination) to detect if they became infected.
- Ensuring that feeds, water, bedding, equipment, and supplies are free of infectious agents.
- Restricting the use of manure-disposal equipment.
- Testing the replacement herd for the presence of pathogens.
- Using high-health technologies (for example, artificial insemination, embryo transfer, surgical derivation, and medicated early weaning) to introduce new genetic stock.

Many of these options are based on common sense, but some of the specific elements are difficult to control or implement. The seasonality of biosecurity calls for different measures to be taken at different times of the year. In the fall, wild-animal populations begin to seek additional shelter, warmth, and food supplies, and the domestic animal facilities offer much of what those animals seek.

In those situations, wild animals can spread disease to domestic populations. Similarly, quarantine, disinfecting, and clothing changing are often highly effective measures to counter the spread of potential pathogens. Realistically, few producers have the resources or time to increase their operations to provide for showers and change of clothes every time they enter a different animal facility. If these measures are to be effective, the ease of implementation must be balanced with the return.

APPENDIX
4

Electronic Commerce on PEI

INTRODUCTION

This virtual case study was carried out as part of the Knowledge Assessment Methodology Project in Prince Edward Island. As one element of the methodology, virtual case studies are used to explore the weaknesses and strengths of the knowledge economy, employing as a vehicle the planning of a hypothetical, knowledge-based enterprise in an area of comparative advantage that is affected by technical change. It is emphasized that this report is almost entirely drawn from the expertise and experience of the participants, and is not intended to propose that such an enterprise actually be established on PEI.

The virtual case study on electronic commerce was conducted on the campus of the University of Prince Edward Island on May 11, 1998. Participants included representatives of the Information Technology Association of PEI, the Provincial Government, the Federal Department of Veterans Affairs, the University of Prince Edward Island, Holland College, and the private sector. The U.S. National Research Council was represented by Diane Wetherington, president of DRW Associates, which provides new products services to startups focused on IT and consumer applications; Chris Deephouse, Principal Engineer, CyberCash, Inc., responsible for coordinating software and process engineering with software vendors; Phyllis Reuther, of the Heinz School of Public Policy and Management, Carnegie Mellon University, specializing in electronic commerce, business process redesign, and Internet agent technology; and Michael Greene, director of International Development Programs at the National Research Council.

BACKGROUND

Advertising and selling through the Internet is called electronic commerce, or E-commerce. The Internet is growing exponentially, with new servers and Web-sites sprouting nearly everywhere in the world. World-wide Web software technologies are enabling any user to become an information provider of one sort or another and providing any business with a low cost advertising and selling medium. Almost no one doubts the power of the Web to enable businesses to reach literally millions of potential customers at a cost which is nearly independent of the size of the customer base, and which is gradually falling with time. The software for creating Web-sites, advertising, and selling is advancing rapidly, and as distance and location are scarcely a factor, the competition from companies and places that were little- or unknown a short time ago is growing.

On the other hand, very few companies are making a profit in E-commerce today. The reason for this is not clear. It may be that the nature of the market is not well understood and sales techniques for this new medium have yet to be perfected. It may be that technologies for effecting payments, although quite adequate in technical terms, do not yet have public confidence. It also may be that this is a temporary situation, and Internet commerce may explode across industries and national boundaries.

For a variety of reasons, the characteristics of E-commerce seem to favor PEI. For many consumers, PEI is little known and physically hard to reach in a geographical sense, but it is as easy to find on the Web as the largest city or country. The stories of Anne of Green Gables and its place in Atlantic Canada give it a theme and an aura of romance. And in quite another sense, PEI is ready to go. It has a digital broad band backbone across the Island that may be the most advanced in North America, and which could be made accessible to businesses and industries of many kinds. It has a prize-winning official Web-site and a number of private companies with attractive and interesting sites. At a time when Web-based industries are sometimes "footloose," businesses whose major assets walk out the door every evening at five, and who can relocate to another attractive site with little notice, PEI has a loyal population who appear committed to remaining on the Island if the right jobs are available. Nevertheless, in exploring the advantages of E-commerce in Prince Edward Island in the course of the knowledge assessment, it seemed expedient to base the enterprise on a unique feature of the Island that would not be easy to carry off.

The theme selected is Anne of Green Gables. Familiar, and even tiresome, as it is to Islanders, this is clearly an asset or core competency of PEI. Anne is known throughout the world, driving a significant part of the PEI tourist industry, and offering a fertile basis for chat rooms and Web-sites designed around the novels. It could also be a wedge into the incipient IT industry for girls. A world-class Anne site could become the "anchor store" in a "virtual mall," of electronic commerce businesses located on Prince Edward Island. The anchor store in a

mall is generally a known attraction; it reduces risk for other stores since it sets up the infrastructure that is shared by all and draws in customers. With the Anne site as an anchor for E-commerce business on PEI, it can provide the infrastructure for high-volume, secure electronic transactions that new web businesses will need to derive revenues from the Internet. The Anne site could also serve as an incubator of E-businesses by adding expertise to the Island and by helping to bring the electronic commerce skill level on PEI to World Class levels.

Several ideas for the content of the Anne Web-site include:

- develop a magazine based on the story of Anne of Green Gables featuring new Anne adventures written by local writers and illustrated by local artists;
- market Anne products produced by PEI craftsmen and merchandisers;
- host chat rooms for "Friends of Anne" to be able to communicate from around the world;
- sell tour packages to PEI to visit Anne's home or seasonal offerings such as Christmas at Anne's.

The site should feature writers, craftsmen, creative artists, tourism, package travel, merchandise, and other businesses found on PEI. Regardless of the content actually developed for the Anne site, the advanced infrastructure developed—Internet and non-Internet marketing, receiving payments, data base management, supply chain management—could also serve the potato, lobster, and livestock industries and any other business on PEI.

THE ENTERPRISE

The virtual case study will describe an enterprise, whimsically called Anne-with-an-"e"-Commerce (after the Anne character who likes to clarify the spelling of her name), or, as the anchor store in a virtual mall, Anne-E-Mall.

Statement of Purpose

To build on one of PEI's unique attributes, Anne of Green Gables, to create a profitable, diverse "E-mall" on the Internet, which will in turn develop the human and technological capacity for E-commerce.

What are the product and services?

The product is a linked array of interactive, informative, and retailing Web-sites, as in a mall, with the anchor site providing billing, accounting, shipping, Web-site design, and quality assurance services to the participating merchants and the public.

Who are the customers?

Two groups of customers exist:

- on the supply side, the various providers of retail goods, tourism products, and cultural and literary products and services on PEI and elsewhere, who might wish to use the Anne-E-Mall as a way to reach their target markets; and
- on the demand side, the "young and young at heart" fans of Anne and of PEI worldwide, including former Islanders "away," who would visit the site, obtain information, subscribe to on-line magazines, purchase products, and interact with each other and with suppliers. Particular emphasis would be placed on a core audience of young girls who are currently under-served by the Internet and by the computer software industry.

The Anne-E-Mall stands to realize revenues from both groups.

Who are the competitors?

Competitors for customers on the supply side include firms on PEI and in the regional market who would compete for the Web business of tourism operators and retailers. On the demand side, the competitors include other Web-sites aimed at the audience of young girls, such as Madeleine, Spice Girls, Disney, etc. In both cases opportunities exist to turn competitors into partners by linking them into the Mall.

What technologies will be used?

The important technologies are the local IT infrastructure for high volume, interactive, secure transactions and the local human resources with capacity for Web-site design and marketing. The resources and skills required do not depend on the Anne theme, and would serve as well for other products. The broad band network with supply points in PEI at community access (CAP) centers or where businesses originate will make the Mall accessible to a wide range of enterprises. Web-site design, going beyond good HTML, will include creating focused chat rooms, interactivity, publication siting, and secure communications for transactions.

What is the core competency that gives PEI a competitive edge?

The core competency that gives PEI its competitive edge is the Anne theme, unique to PEI, which enjoys global recognition and offers a host of related commercial opportunities.

PRODUCTION REQUIREMENTS

High-speed lines would be required for the dynamic interactive content of the site and potentially for the volume of transactions. The broad band network is in place within the province, with ATM enabled technology in the 150 MHz range available at about 14 central "points of presence" (POP), as broad as anywhere in North America. If anything, PEI is over-provisioned in band width. In addition to the broad band network within PEI, there is Canarie, a consortium of universities, research establishments, and businesses funded by Industry Canada and providing a high-speed off-Island link among partners that could be scaled up for commercial use.

The PEI broad band network can be switched into a new business for about C$25,000. A T-1 connection in PEI currently costs about $1,000 a month. Small firms may find this cost a burden compared to out-of-province alternatives, and opportunities to share a site with like firms are limited in PEI at present. Most firms in PEI are currently connected at speeds of 64 to 128K. The proposed electronic mall would overcome this barrier by providing a common high-speed infrastructure, realizing economies of scale for participants.

The Anne-E-Mall could be sited near any of the POP sites to minimize additional expense. However, a Charlottetown location would maximize access to the skilled labor pool, the post-secondary educational system, and the airport.

Each business that wanted to participate would have to work with Island Tel to get the bandwidth it will need for its particular purposes, and could receive at the same time assistance with late generation Web-sites. In many cases, the bandwidth required would be modest, and it might be useful for the purpose of generating Internet commerce activity for Island Tel to consider offering a share in a high bandwidth connection at reduced rates, equivalent to several users sharing the cost of a T-1 connection in places where high-bandwidth Internet users are more numerous than on Prince Edward Island. When the Mall is in operation, the Anne-E-Mall itself can broker the sharing of bandwidth among partners.

There should be an attractive rented facility that would provide a pleasant workplace and bring people together. It might also include a fulfillment area or an area where merchandise could be brought by different merchants for combined packing and shipping to customers who purchase products on the Internet from multiple craftsmen.

Siting is important in another sense. There is a great deal of competition on the Web among commercial sites for "prime real estate" on Web searches. The Anne-E-Mall Web-site must be designed to appear on the first page of a search by a search engine like Yahoo. A consultant familiar with the algorithms search engines use to locate new Web-sites could be helpful in positioning the Anne site on the first page search results. Typically, Web-sites identified on the first page experience a higher volume of visitors to their sites than sites identified later in

the search process. This work would have to be carried out on an ongoing basis to ensure continued results.

Required equipment to launch the Web-site would include a local area network (LAN), with a local server and gateway and a workstation for each worker. Multimedia, video animation equipment and sophisticated software are also recommended.

Local subcontractors are available to provide essential support. Packaging and shipping could be outsourced. Customer support by e-mail and phone could be handled by a local call center service bureau, with training of technicians contracted to Holland College. The quality of this training is critical, as customers will not distinguish between the E-mall and the subcontracted customer support. A training program in electronic commerce, using Holland College's skill-set core competency method, could be useful to other participating businesses as well.

Another useful subcontractor will be an Internet service provider (ISP). It should ideally be located on the Island in order to take advantage of the high bandwidth available, but a mirror site might be set up in Japan with a separate Japanese company.

The core business of Anne-E-Mall is the provision of a highly attractive Website with a secure, high-volume infrastructure for electronic marketing and sales, and in a sense the craft creators, travel agents, hotels, and artists whose wares are sold function as suppliers. The revenue comes from advertising, commissions, and eventually the sale of software packages and games, when the capacity exists within the company to create them. But the Anne-E-Mall is more than a catalog of products and services; it must link all the Anne pieces together and produce a seamless presentation to customers.

It is therefore important that the Anne-related craftspeople are engaged as partners who share the rent for space on the site. Other unrelated businesses or events, like a PEI writers' congress, might pay for listing and services as needed. Items produced by partners can be ordered at the Web-site, and the others can be announced and hot-linked. Performance criteria will be required for those businesses that sell products and services on the site to maintain quality and protect the reputation of the site.

Special policies will be required for supply chain management; the company must be sure that what is marketed on the Web-site can be delivered. It will be necessary to avoid swamping small suppliers who have limited capacity (or desire) to produce in quantity with orders they can not fill. Devices such as "available in limited quantities" or "each item numbered and signed" can produce an aura of exclusivity and turn a potential liability into an asset. However, there must be an agreement about quality assurance and delivery times with all vendors on the site, possibly by having an on-line inventory that can be drawn down. If Anne-E-Mall accepts payment, in the customers' eyes it is responsible for quality and delivery, and must therefore be prepared to deal with returns and complaints.

It may also have to consolidate shipments from different vendors ordered by each customer. Collection and storage of inventory, with inventory control and measures against pilferage, must be included in agreements with partners. From the customers' perspective, the business must appear unitary.

HUMAN RESOURCE REQUIREMENTS

There are several sides to the business: the technical and design aspects of producing and maintaining a late generation, interactive, secure Web-site; the marketing of products to a world-wide audience through the Internet; and the development and management of the supply chain.

The first side will involve design and content specialists, able to do Web-site development, using Java as well as HTML, and manage chat rooms, maintain the connections to the ISP, and generally keep the system up. Some knowledge of cultural issues, for example, relating to the acceptability of certain graphics in different countries, would also be useful.

The second skill area involves selling to that global market. A mixture of skills is required for accessing market information, using data base management capabilities, and accessing legal expertise for licensing and import/export issues. Some of the regulatory issues relating to intellectual property rights and shipping into different countries might be subcontracted to lawyers or affiliates in PEI.

The third skill is assembling the supplier/partners, dealing with quality, delivery, contracting, and transaction management, and assuring that partners are paid for their sales. While such skills have long been required in the retail sector, the shift to E-commerce makes a difference. A multitude of suppliers, varying in their scale, capacity, quality, sophistication, and level of IT automation, must be assisted to move, perhaps very rapidly, to serving a demanding global market.

Altogether a core team of 5 or 6 experienced people might be necessary for startup. Such people are hard to find on Prince Edward Island. They are in high demand, and inevitably they will be associated with other organizations. Recruiting from outside the province, perhaps among the large network of "Islanders-away" would be more beneficial to building PEI's IT capacity than would recruiting locally. It might also be possible to have people seconded from suppliers such as Island Tel or the ISP in order to get the company running as permanent staff are recruited.

Eventually the skills must be produced on PEI. Holland College is developing a new three-year program in Web design, combining elements of their current long-established programs in Visual Communication and Business Information Processing with a new third year in Multimedia Design. UPEI has recently expanded its Computer Science program from two years to four. The university's Information Technology in Education Center (ITEC), which is designed to assist professors to prepare distance learning materials, could assist with interactive site content on a contract basis. It is notable that ITEC had to recruit off-Island to

obtain those skills. There are also training programs available in the summer linked to Dalhousie University in Nova Scotia, and it would be useful to offer practicums to the students with local Web design companies. Alternatively, ITAP could offer courses on design work with the help of private trainers on the Island.

LEGAL AND REGULATORY REQUIREMENTS

It has been assumed for the purposes of the case study that intellectual property rights to electronic Anne can be secured. In practice, one of the first tasks of Anne-E-Mall team would be to research the issue and obtain the necessary licenses. There are no regulations that explicitly pertain to the World-wide Web, and many Web-sites use quotes without permission. However, the name Anne of Green Gables and the name of the author, Lucy Maud Montgomery, are trademarked by the Province of PEI for use on-Island. Products based on Anne that are made and sold on the Island are not subject to royalty payments. Products that are made on the Island and exported pay reduced royalties. These payments must be made to the Province; royalties from companies based off the Island are made directly to the family of Lucy Maud Montgomery. The Province has licensing authority, including for depictions of Anne, which must be approved in advance. (This is another service that Anne-E-Mall can do on behalf of the other partners.)

All products sold through the Mall must satisfy safety standards of the Canadian Standards Association (CSA), and partners must be asked to provide certification for their products where applicable as a condition for participating. They must each be insured as appropriate to protect themselves, and all processes and procedures of Anne-E-Mall must be clearly documented to limit its liability. All necessary insurance is available in PEI.

For exporting, regulations and tax laws of receiving countries must be investigated; Federal Express and Industry Canada can assist. In case of difficulty, it may be necessary to limit the areas to which merchandise can be shipped.

MARKETING

Marketing will be done mainly on the Internet, and this will require, among other things, that the Web-site come up early in searches. It is good practice to keep track of hits, either by asking visitors to sign a guest book or by storing a cookie on their machines, with their permission. Additional advertisements can be placed in magazines serving young girls, and the reach of the sites can be enhanced by crossing links with other sites. Mail campaigns can be mounted using mailing lists from merchants, the Provincial visitors' list, and other PEI sites.

While Anne-E-Mall should concentrate on the short term initially, it should always use the most advanced technologies and maintain awareness of advances by participating in conferences and looking for innovative Web-sites on the

Internet. In the longer term, technical staff should develop the technology to create an Anne's World virtual theme park on the Web that would provide a virtual experience of PEI and attract visitors and customers.

IMPLEMENTATION PLAN

For the Anne-E-Mall enterprise, the Provincial Government might provide funding through Enterprise PEI, likely in the form of a loan or equity stake. This would be useful for seed money, to get the project to a point that would attract private investors. However, seeking funding from the government might make the proposal public knowledge, and there is a risk of being scooped. It would be necessary to have in place an experienced management team and a completed Web-site design before seeking private backers. At that point, venture capital could be pursued, although the amount required is small for most venture capitalists. Board members and suppliers may also be interested in an equity stake.

The first step should therefore be to seek seed money and develop the Web-site that can be used to sell the Anne-E-Mall package. Startup costs may perhaps be kept under $500,000, but additional capital will be required when sales start to move. Probably a more realistic minimum is $1 million, and the management team may be given an equity position. The initial team should include a graphic designer, a Web-site designer, a marketing expert, someone to take charge of development of contacts and contracts, and a financial management person. A production manager will be required to choose products, establish prices, and set up processes for payment and delivery and for customer service, making a total of six. An accounting firm and legal advisors can be kept on retainer.

It is essential in this kind of business to get clear rights to the electronic use of the Anne of Green Gables theme and image before launching. After that, the main bottleneck will be finding and training the people. In other places, recruits might be offered stock options, but this is not common on PEI, and workers are more likely to seek quarterly bonuses. Effort may be concentrated on recruiting Islanders living away, many of whom seek opportunities to return to the Island. An IT job net, coordinated by ITAP, may be effective, perhaps combined with a governmental campaign declaring PEI a "silicon island," and offering special consideration or tax breaks to IT specialists and entrepreneurs who move there to work.

APPENDIX
5

Wind Turbine Manufacture on PEI

INTRODUCTION

This virtual case study was carried out as part of the Knowledge Assessment Methodology Project in Prince Edward Island. As one element of that methodology, virtual case studies are used to explore the weaknesses and strengths of PEI's knowledge economy, using as a vehicle the planning of a hypothetical, knowledge-based enterprise in an area of comparative advantage that is affected by technical change. It is emphasized that this report is almost entirely drawn from the expertise and experience of the participants, and is not intended to propose that such an enterprise actually be established on PEI.

The virtual case study on wind turbine manufacture was conducted on the Charlottetown campus of the Holland College on May 13, 1998. Participants included representatives of the University of Prince Edward Island, Holland College, the Atlantic Wind Test Site, the Canadian National Research Council, the Atlantic Canada Opportunities Agency, Maritime Electric Company, the Provincial Government, and the private sector. The U.S. National Research Council was represented by Jamie Chapman, president of OEM Development Corporation, manufacturer of control systems for wind turbines; Andrew Kruse, co-founder of Southwest Windpower, Inc., the largest manufacturer of small wind turbines in the world; and Michael Greene, director of International Development Programs at the National Research Council.

BACKGROUND

Canada has a small wind energy community, and the members are not yet big players in making national energy policy. Although, worldwide, there are more new installations in wind turbines than any other form of energy supply, wind does not yet figure highly in the energy strategy of Canada. Most of the energy utilities are Crown Corporations belonging to the provinces, and energy prices are kept relatively low. In PEI, most of the energy is purchased from New Brunswick Power and brought in by cable from New Brunswick, where it is produced mainly by nuclear and thermal plants. The cable presently has excess capacity; peak demand is 145 MW, and the cable capacity is 200 MW. There is a 30 year old thermal plant on the Island that can be used as a supplement at peak demand but is usually idle.

Worldwide, the wind energy business generates $1 billion in revenues. There are three categories of product. The largest wind turbines, of the order of 500 kW to 1 MW, have blade diameters like the wings of a large airliner, and are used for wind farms connected to the grid through a bank of transformers. These wind-driven turbines are now competitive when aggregated into power plants on the scale of 100 MW. For example, Northern States Power, a large utility headquartered in Minneapolis, selected a commercially available 750 kW, variable-speed wind turbine, the Zond Z-46, for a 100 MW wind plant on Buffalo Ridge in southwestern Minnesota.

Total delivered power world-wide is about 8,000 MW. These are high-technology units, with sophisticated aerodynamics, advanced materials and alloys, and they depend upon control theory and computer-controlled manufacturing; the installed capital cost can be as low as US$1,000 per kW, and falling. The competition for these installations is with other energy sources, like coal, nuclear, and thermal. The cost of energy from a wind farm is about 4-6 cents per kWh, which in the United States tends to be higher than the cost of alternatives, but the competition, such as gas-fired combustion turbines, is also becoming more efficient. In any case, the large castings required and transport costs of getting materials and product on and off the Island probably make this category not suitable for PEI.

Smaller machines, however, would be achievable for Prince Edward Island with a straightforward extension of current capabilities. These turbines are used for village power systems, agribusiness, and water pumping. The largest of these turbines are in the range from 10-15 kW up to 50 kW. The market for this range is growing in the Canadian Arctic, and developing countries. They are useful in remote areas, but they are capable of supporting an urban life-style for a home or residential compound. The capital cost is in the range $2,000-$2,500 per kW. In markets where electric energy is now unavailable at any price, these installations can be the most attractive option to provide needed service.

At the small end of the range are microturbines of about 500-1,000W capac-

ity. This is the fastest growing market, with many consumer applications and a potential market of 2 billion people without power today in rural areas of developing countries. The smallest wind turbines sold in North America today are about 300 watts and sell for less than $500, including the supporting tower, well within the range of developing country microfinancing schemes. The variable nature of the wind resource diminishes as an issue when the turbine is one component of a diverse village power system that includes photovoltaic collectors, battery systems, diesel generators, and the like. Wind turbines would capture a significant share of this market. In a database of some 300 village power systems installed worldwide, maintained by the National Renewable Energy Laboratory, 52 include some form of wind turbine.

For the smaller machines it would not be necessary to set up a foundry or die casting facility, which greatly simplifies the manufacturing. They could use a direct drive transmission system, so that a gearbox, which otherwise would have to be imported, would not be necessary. The business could be mainly an assembly plant, which would fabricate the blades and perhaps contract out the rest. If suppliers with the necessary facilities were available, the plant would not need to acquire a lot of capital equipment. The major part of the business would be to assemble, test, and market.

There are several good reasons to locate a wind turbine manufacturing enterprise on Prince Edward Island. The Atlantic Wind Test Site on PEI, a Federal facility, is available to carry out research as well as testing of wind machines. Slemon Park industrial park houses aerospace and electrical component manufacturing companies that could serve as component suppliers, and provides infrastructure for turbine manufacturing. The cost of doing business in PEI has been assessed by the Atlantic Canada Opportunity Agency (ACOA) and compared to other Canadian provinces, Europe, and the United States. The results show relatively low capital and labor costs, and a favorable tax situation. Startup funding is likely to be available from a variety of sources, both governmental and private, on the Island and off.

The enterprise selected for the case study would produce category 2 and 3 wind turbines for an off-Island market. With low energy prices and a small population, PEI does not offer a sustaining home market for wind turbines. The company would seek marketing opportunities in more remote Canadian territories and islands where connection to the grid is not an option, in developing countries, and for camper, boat, and battery charging use.

THE ENTERPRISE

Statement of Purpose

The enterprise would establish a wind turbine manufacturing business on PEI.

What is the product?

Initially there would be two product lines:

- small wind turbines of 500 and 1,000 watts
- wind turbines in the 10-15 kilowatt range.

In the medium term, the company will move into integrated wind energy systems, combining wind with diesel and perhaps photovoltaic for remote applications, or for net metering applications in urban areas. In the longer term, it would explore the potential for larger wind turbines of several hundred kilowatts that would be used to manufacture hydrogen for on-site sale to the anticipated motor vehicle fuel market.

Who are the customers?

The initial product lines would serve the following markets:

- the small 500-1000 watt turbines would be aimed at the rural remote residential market in Canada and developing countries where connection to the grid is not available or not affordable. It would also be suitable for use aboard boats and in campsites.
- The larger 10-15 kW turbines would serve users in remote areas, including rural communities or businesses.

Who are the competitors?

A large number of firms are engaged in the manufacture of wind turbines, but most of them are not doing well. However, the potential market is so vast that many feel that the entry of additional companies expanding the technological base and advertising their wares helps enlarge the market for all, and there is much cooperation among wind machine producers. The real competition is with diesel generators, solar energy systems, and small gas turbines.

What technologies would be used?

The technologies required in the manufacturing process include, among others: die casting, injection molding, stamping, armature winding, powder coating, welding, CNC automated machining, circuit board manufacture, and special packaging. The enterprise will be mainly an assembler, with most manufacturing outsourced locally.

What is the core competency that gives PEI a competitive edge?

The core competencies present in PEI are the expertise in wind energy represented by the Wind Test Site, the proximity of suppliers and technical services, and the ingenuity, capacity, and loyalty of its labor force.

PRODUCTION REQUIREMENTS

Traditionally there has been little or no large scale manufacturing industry on the Island. Most manufacturing has been related to farm implements and agroindustry based on the potato crop. There are also small foundries and facilities for propeller manufacturing, including sand casting of marine screws and CNC machining. A cluster of aerospace firms is developing rapidly at the former air force base at Slemon Park, Summerside, however, and there are additional centers of expertise in the other Maritime Provinces. Most of the technical and manufacturing services that would be required are right at hand at Slemon Park. Storage space is available.

Die casting could be outsourced to Wiebel Aerospace, Inc., located at Slemon Park. They are set up to do small pieces but could tool up for larger jobs if there were a market. Other companies can be found in Moncton or Halifax. For injection molding, there are small companies in Springhill that could handle the jobs. Armature winding could be done in Moncton, or armatures could be hand wound in-house. Powder coating can be found in most cities, and a paint company is expected to locate at Slemon Park. Welders will be trained at a new welding institute planned at Holland College in Georgetown. CNC machines are available at Slemon Park. For circuit boards, it will be necessary to go to Moncton, but a company is expected locally within a year. Packaging should not be a problem since local boxing plants are capable and underutilized.

Testing is important for wind machines of a new design. Company engineers must develop a testing protocol, and the machines must be tested in different environments. An advantage of PEI is that it presents a challenging environment for wind machines, and the Atlantic Test Facility is available to assist with the tests. In potential markets in other parts of the world, it may be possible to get universities to test them by denoting a machine to a science or engineering department.

The design is critical. There are three options. The company can license the technology, it can work with an experienced wind turbine engineering company to develop a prototype, or it can do the research and development to design a turbine from the beginning. An intermediate option would be to pay a license fee to get a suitable design in order to get a model on the market and get the cash flowing. Then the design can be modified, with a concomitant reduction in the royalties.

Protection of the design of the machine itself is difficult, in any case. This is

especially true if many of the customers are overseas, and it would be necessary to take out patents in many countries, which is expensive and of little value unless the company is prepared to go to court in a foreign country against a local company. It may be better to protect the product by maintaining low prices, high quality, and keep proprietary relationships with suppliers and contractors.

If the machine is designed from scratch, it can be expected to take two years to produce the first prototypes. From there, experimental modeling, recasting, and the step to manufacturing can take another year. Finally it will be necessary to test and tear down prototypes in order to analyze stresses for about a year in harsh environments to be sure the product is reliable.

For shipping, the industry commonly relies on major carriers such as FedEx, Purolator, and DHL to transport its products to their markets. In PEI, the firm would have access to air transport connecting to Halifax's international airport, trucking, with significantly reduced costs since the opening of the Confederation Bridge, and marine shipping from the port of Summerside. The northern winter climate can have some impacts in terms of iced-in winter ports, and closures of airports and the bridge during storms. Airport closures are rare and short-lived, however, while measures are in progress to ensure transport trucks can continue to cross the bridge under most weather conditions. Firms currently located at Slemon Park attest that logistics have not been a concern, despite initial expectations to the contrary.

HUMAN RESOURCES

The success of the enterprise ultimately will depend on the people behind it. Some key skills may be combined in a single individual or they may be embodied in a team. Skills are personal; sometimes they accompany an advanced degree from a prestigious institution, and sometimes it is college dropouts who have the energy and vision. Perhaps the key individual will combine technical insight and an understanding of the physics of wind turbines with vision for the future of the market and of the business. There must be at least one individual with the technical and engineering capability to make incremental improvements in the technology, whether it is licensed or designed in house, and to keep the products up to date. There also must be someone with knowledge of markets and with skills at selling in a variety of different environments, national and international. And there must be a "hard-nosed spender," someone who ruthlessly keeps costs low and is not afraid to say that if a product is not making money, it should be "killed."

The engineering skills can either be recruited on PEI or from the other Atlantic Provinces. The university offers two years of engineering, with the opportunity to complete the degree at the University of New Brunswick. It might be worthwhile to attempt to reach and recruit engineers from among the Islanders-away community. It is also possible that skilled people can be shared at an industrial site like Slemon Park, as is currently the practice, individuals who are

employed by one company but "jobbed out." Although formal research and development may be beyond the reach of a startup wind energy company, it is important that the engineering staff follow trends and product development in order to make incremental innovations in aerodynamics, power electronics, and integration with other power resources.

For the marketing specialist, the challenge will be to find someone who is comfortable in many markets, including boats, mobile homes, rural developing countries, water pumping, off-shore oil stations, field monitoring devices. The person must like to travel, even to remote areas, and be at ease with government officials, World Bank economists, and technical sales departments; he or she might even speak several languages. An engineering sales background with skill in proposal writing would be helpful. (Bilateral aid agencies or international development banks will frequently fund sales in developing countries.)

It is important that marketing staff be permanent, since long-term relationships with suppliers, distributors, and customers are essential to the success of the firm. The strategic question always will be whether to "buy it or build it": finding and recruiting a skilled person at high cost, or getting a dedicated person who can learn on the job. In general the approach should be to start small with a minimal staff and make use of consultants as long as possible while the staff is being built. The best strategy may be to recruit core competencies, and contract or hire the rest for two years, keeping the company as lean as possible during that time. There are dedicated people in this field, and their resumes can be collected at conferences.

A skilled production workforce is also necessary to the success of the enterprise. Experienced, trained fabricators are in high demand. PEI enjoys some notable advantages in this regard. Holland College is planning to establish a new welding and fabrication institute with a two-year program in Georgetown, graduating fifty workers a year trained to ISO 9000 standards. Islanders' commitment to place ensures strong workforce loyalty and low turnover despite relatively low wage rates (estimated to average C$12/hour including benefits for floor workers). The Island's primary industry base has fostered an adaptable workforce with a strong mechanical bent and a capacity to work independently. Existing manufacturing firms attest to the ingenuity and work ethic of their employees.

LEGAL AND REGULATORY REQUIREMENTS

The permits required are related to safety and protection of the environment, and all are standard and normal. The Provincial Government is not likely to erect roadblocks to new industry; to the contrary it will make some effort to assist startups or franchises.

There are both Federal and Provincial taxes. Companies established at Slemon Park are entitled to a ten-year holiday from the 23% Provincial tax. The Federal corporate tax rate is 17%, with allowances for carry-forward of losses.

There are additional benefits for companies creating employment in depressed areas, and for training. There are capital cost write-offs for wind generation and separately for non-oil power generation; but some of these may apply only to power generated on the Island, not for generators sold off-island. This would be an additional reason to explore net metering on PEI, where the wind power-equipped home feeds power to the grid, slowing or reversing the meter and saving money when power is generated while drawing from the grid when the wind is low—in effect, using the grid as a battery. Net energy billing does exist in some Canadian provinces but not yet in PEI. The equipment has to be CSA certified, and the approval of an electrical inspector and the utility are required. There are several issues to be explored regarding pricing; for example, whether the energy will be bought for the same price as it is sold for. With the current energy pricing structure on the Island, there is no advantage to the utility to purchase "green energy."

An environmental impact statement would probably not be required formally, but the project would be submitted to the Provincial Environmental Department, and there may have to be adjustments to the site or facilities to protect air, water, and soil. The terms, however, could be included in a negotiated package.

Standard liability insurance would be required; it is necessary to hold distributors harmless from claims relating to the wind machine. This insurance is not expensive.

At present there are no UL safety standards in place for wind turbines, and there is an effort by manufacturers to create them. There are CE performance standards for the European Union. At present ISO manufacturing process standards are not important in the industry, but in the future they may apply to the component suppliers. Canadian CSA standards will be required for the electrical components if the machines are connected to the grid, and certification is expensive and time consuming.

MARKETING REQUIREMENTS

Multiple markets exist for the micro and small wind turbines examined in this case study. The developing countries are the largest markets in the long term, but these are also the hardest to address. Key issues include cost, service, and local delivery. Those with the largest markets may also insist that some assembly take place locally, although this demand may be met in part by having towers constructed locally. This measure also simplifies shipping by confining it to the high-value product. It may also be necessary to pay local agents to get the required permits from local officials.

A strategic asset for this market is Canada's generally good relations with most developing countries. Government agencies such as Canadian International Development Agency (CIDA), the Department of External Affairs, and the Export Development Corporation can all be helpful in identifying, developing, and

financing export opportunities, while ACOA can assist with domestic efforts including market research and planning. The federally initiated "Team Canada" overseas trade missions with the Prime Minister and the ten Premiers have also played a major role in developing export trade in recent years. PEI's membership in this group provides an opportunity to get wind energy on the national trade agenda, once the manufacturing facility is established.

The key competing product is solar power, which many potential customers accept as an effective, non-polluting energy source, with no moving parts and a thirty-year life. It will take an effort to convince them that wind is better. The wind product will have to be reliable and have a long warranty, but also it will be necessary to demonstrate that wind produces more energy, more consistently, than solar power. Often this can best be done by simply donating a machine to a potential customer or partner in order to measure power output, and at the same time measuring customer satisfaction.

Customers and pricing should be charted in advance, and a marketing plan produced. Much of the information necessary is available on the World-wide Web. The new company should develop a competitive Web-site. Besides advertising, the Web-site would provide a source for ordering parts and accessories, and for dispensing technical assistance. Payments can be made through secure credit card transactions.

To find customers overseas it is often necessary to have a registered agent in the country, and this will require a visit to the country by the marketing director. Next the agent and the director together should find a good distributor to be a partner in the country. This local partner should have multiple retail outlets and an engineer on staff to answer technical questions. The partner places advertisements in major magazines, and even classifieds in selected local media. The partner buys products prepaid or with letter of credit; credit terms are not common. In some circumstances it might be necessary to contract with a local company to make warranty repairs and dispense spare parts.

It is critical to gain an understanding of each country in which the product will be sold. Some countries have multiple markets segmented by region, religion, ethnic community, etc., and more than one distributor may be necessary. Sometimes it will be possible to partner with vendors of solar equipment in a promotion of hybrid systems. Finding the right partner for an overseas market is of critical importance.

It even may be advantageous to maintain a sales office off the Island. Flying in and out of PEI is expensive, and the local market is not expected to be large. Some Island companies maintain office locations in Ontario, Quebec, or in the United States. In the long term, it would be advantageous to have sales offices in host countries and close to markets. A related option to contain travel costs would be to partner with a Canadian firm to keep in touch with partners and customers.

The remote communities of northern Canada, some 350 in number with populations ranging from 150 to 5,000, constitute another major market for the pro-

posed enterprise. Few of them are without power, but most are off the grid and rely on diesel powered generators put in place by the utility companies. A modern diesel plant, well operated for 24 hours a day, produces power at from 25 cents to one dollar per kWh, and the energy use in these areas is very heavy.[5] The Canadian Government subsidizes energy costs, including the cost of transporting fuel, and would have to be persuaded to support hybrid systems. In addition, there may be a market in the hunting camps for microturbines with battery chargers, which are cheaper, lighter, and quieter than diesels.

In general, utilities can avoid extending the grid to remote areas by setting up integrated renewable systems, and using net metering to pay off the cost. The machines might be sold directly to the utility to install and sell to homeowners. In PEI they may be offered as a backup in the event New Brunswick Power was unable to deliver. In any case, it would be valuable to sell a number of units locally for purposes of testing in PEI's maritime environment, and also for marketing the wind turbines, especially the small machines, as a PEI product, used by "the independent Islanders in Anne's Land." With some ingenuity, a package could be developed that would allow Maritime Electric to include home generated renewables as part of a total energy delivery picture. It might be possible to develop the know-how to offer a complete package, including the economics of net metering and distribution, which could be sold to developing countries.

IMPLEMENTATION PLAN

The new company might start with 500-1,000W micro turbine models. According to reported experience in the U.S. Southwest, it would require about C$2 million to begin operations for the first eighteen months. By the end of that period, the company should have about 35 people and produce 250 turbines a month, assuming that the turbine design was licensed or developed on contract. At the end of a five-year growth period, the firm could be producing 1,500-2,000 units per month. This production should provide the cash flow to support refinement of the product design and expansion into new models and markets.

An array of financing options is available to assist the enterprise in getting established. Normally, new companies apply to Enterprise PEI and to ACOA for loans, financing, and siting, and frequently are successful in obtaining some form of financial assistance. Loans can cover up to 60% of eligible costs such as buildings, equipment, training, and environmental protection measures, up to a level of $1 million interest free for ten years. Alternatively or additionally, Enterprise PEI might take an equity position, and then allow the company to buy back the shares gradually when it is stronger. Slemon Park Corporation can also provide

[5]The cost is much higher in many remote regions than in urban or agricultural centers. Transport costs, limited maintenance capability, and "evaporation" (theft) determine the price, which can be ten times higher than the cost of fuel.

other forms of assistance; for example, it may arrange to carry out the analysis required for an environmental permit. Additional benefits may be available from Human Resources Development Canada to support job creation and training. The medical package for the employees is provided by the publicly funded health care system.

Financing also might be available from private venture capital funds. The government would require 20% equity held by investors, including venture capital or "angels." The Island has about 30 investors who might be interested in an enterprise such as this. In-kind contributions might also be considered. If the project matches the Government's strategic plan, they will work hard to make it happen.

Potential exists for partnerships with other local firms. For example, FORTIS, the Newfoundland power utility that recently acquired Maritime Electric, could be approached as a partner. It was described as a good, established company that is not risk-adverse, and it may see wind power either as a cost-cutting advantage for the future or an inevitable development that would be better growing inside than outside the power company. Despite the availability of incentives such as accelerated capital cost depreciation for wind energy installations, however, the company would need to be convinced that this was its best choice for an investment.

Other partnering possibilities include the outsourcers in the aerospace industry, that might see wind power as an extension of their business rather than wishing to serve as a component supplier. Partnership may also be attractive to established firms in the wind business in other places. They may be particularly valuable in recruiting staff.

Recruiting the initial management team will be the greatest challenge. Other businesses at Slemon Park report that PEI faces a barrier to recruiting knowledge workers in that it is small, remote, and not well known. Advertisements in appropriate journals may reach the wind community largely in the United States. Islanders-away may also be a source of dedicated and talented people, and could be approached through Web-site and government contacts.

The wind power industry is at an early critical stage, where the potential market appears unlimited, but the marketing effort is still small. Existing producers still welcome the entry of new competitors because the incremental marketing effort benefits all in an expanding market, and they can be helpful. An early entry by PEI can put it at the forefront of a growing knowledge-based industry with global reach.

APPENDIX
6

Telemedicine Services on PEI

INTRODUCTION

This virtual case study was carried out as part of the Knowledge Assessment Methodology Project in Prince Edward Island. As one element of that methodology, virtual case studies are used to explore the weaknesses and strengths of PEI's knowledge economy, using as a vehicle the planning of a hypothetical, knowledge-based enterprise in an area of comparative advantage that is affected by technical change. It is emphasized that this report is almost entirely drawn from the expertise and experience of the participants, and is not intended to propose that such an enterprise actually be established on PEI.

The virtual case study on telemedicine took place on the campus of the University of Prince Edward Island on May 15, 1998. Participants included representatives of the Department of Health and Social Services, Holland College, the Department of Veterans Affairs, Island Tel, the University of Prince Edward Island, regional hospitals, and the private sector. The U.S. National Research Council was represented by Pamela Whitten, director of the Kansas State telemedicine system; Doug Perednia, head of the Oregon program and president of the Association of Telemedicine Service Providers; and Michael Greene, Director of International Development Programs at the NRC.

BACKGROUND

A 1996 report by the Institute of Medicine of the National Academy of Sciences defined telemedicine as *the use of electronic information and communica-*

tions technologies to provide and support health care when distance separates the participants. It has recently gained widely in popularity because of dramatic advances in the information and telecommunications technologies, but it has been used since the 1950s in selected fields, such as remote psychiatry. There are still several different levels within telemedicine:

1. Seeing and hearing through remote real-time audio and video technology;
2. Transferring data, such as radiology, pathology, etc.;
3. Remote manipulation, including surgery, through the use of robotics.

The first two levels have been widely implemented, beginning about 1992 at the University of Kansas and a few other places. Now there are over 70 medical services worldwide that routinely make use of telemedicine technology, and there is an explosive growth in linkages and services available. The third level is still in a developmental stage, and today is primarily of interest to the military.

The situation in Kansas in the early 1990s was roughly analogous to that of PEI, although on a somewhat larger scale. There were remote counties with no physicians, and there was a clear demand for equal access to health care. In 1992, the problem was put in the hands of the medical school at the University of Kansas, and a retired general familiar with military telemedicine applications was put in charge. The state telephone company put in a LAN-based structure with a fractional T1 bandwidth, and equipment was purchased for the university and the potential remote sites. But there was an initial error of focusing heavily on technology and not embedding the telemedicine service within the formal health delivery system, and the service was not fully utilized. In 1995, the university began to create a needs-based service, beginning with an assessment of needs in rural areas, and technology services were placed in the context of clinical and educational programs.

In the clinical program, patients now see the physicians in one of three modes:

- on an as-needed basis, in an emergency or when a rare subspecialty is required, as they would in the normal practice of medicine;
- on fee-for-service contracts for specific services requested by the rural center; and
- at regularly scheduled subspecialty clinics. For example, there might be an oncology clinic on a given day of the month, cardiology on a different day; other specialties might be dermatology, psychiatry, and rheumatology.

A scheduler at each rural center arranges appointments for patients. In all cases, the specialist receives x-rays and other data at the patient's appointment time, and he or she can examine and interact with the patient privately through an interactive audio-video (ITV) hookup, assisted by a nurse specially trained on use

of the equipment. There is special peripheral equipment for the ITV, including stethoscope, otoscope, etc., that directly transmit diagnostic data.

The educational program provides the special training for the nurses who present patients via telemedicine. It also makes available continuing education for physicians, nurses, and allied health care providers to allow them to maintain their licenses and, incidentally, to relieve the isolation. There is an ITV guide, with a menu of lectures and courses presented to several sites at once to encourage class participation. There are also programs for patient education, such as a series on diabetes, weight loss, smoking cessation, and the care of relatives with Alzheimer's disease. The rural sites pay for their own equipment and phone charges. The university charges health care providers for courses taken for credit, and provides the patient education courses free.

Patients in Kansas now accept telemedicine as a normal part of the health care system. Often they would prefer a live consultation, but the eight-hour drive across the state and the cost are deterrents. At the same time, telemedicine is credited with keeping rural hospitals open by making necessary services available locally through them.

The technology used in Kansas is room-based interactive video with a bandwidth of 384 kHz, used in 28 rural hospitals. There is now also a PC-based rural medicine option, requiring only a PC plus a camera at 128 kHz, useful particularly for telepsychiatry. At lower bandwidth, and therefore lower cost, there are POTS-based (Plain Old Telephone Service) solutions, using a phone and a TV, and World-wide Web based technologies, but these are not popular with physicians. The greatest jump in quality comes between POTS and PC.

In Kansas, telemedicine is now integrated into the health care service, and it has been extended to new contexts. The normal telemedicine service is hospital to hospital. Newer initiatives are based in elementary schools in the inner city, where children who never see a doctor can be linked to pediatricians through the local hospital scheduler. There is also a program in psychiatry for prison inmates, and a home-service, using POTS-based equipment, for geriatric and hospice care.

Oregon's telemedicine program, focused on emergency services, demonstrates another promising approach. Studies throughout the state identified that morbidity and mortality in emergency room cases varied by up to a factor of ten between some rural hospitals and large urban centers. A firm, Life Com Inc. of Portland, Oregon, has developed a protocol-based system of network operating centers (NOCs). The NOCs, which are staffed by physicians, operate as telementors or expert systems supporting emergency rooms in rural hospitals. Protocols have been developed using a system of screens to ensure rapid diagnosis and optimum treatment for over 200 emergency situations. The system is aimed at helping the emergency rooms carry out triage to minimize morbidity and mortality by deciding quickly on whether to discharge the patient, admit locally, or transfer to a larger hospital. This system is credited with significant improvements in morbidity and mortality, and substantial relief and support to the rural

physicians carrying out emergency medicine. The protocols themselves are a knowledge-based product, which the firm is now selling separately.

To evaluate the potential of telemedicine in PEI, with its limited distances and high hospital/population ratio, costs must be considered carefully. The cost of transmission in PEI effectively depends only on band width, with additional tariffs for off-island communications. In the future, it is likely that satellite-based technologies will make costs completely independent of distance. Meanwhile the cost of telecommunications is falling, and the cost of health care is rising. The cost of seeing patients in person is rising with it, when salaries, transport, parking, reception, and overhead are taken into account.

In Prince Edward Island, most of the specialists are located in Charlottetown and Summerside, and patients must come in from rural areas to see them. Points of Presence (POP) sites dedicated to health care can be established, perhaps at the seven hospitals, and the telecommunications links can be set up. The POP will have a room with telecommunications equipment staffed by a nurse or a trained layperson. Patients referred to a specialist will have the choice of a drive to Charlottetown or to a POP for a regularly scheduled clinic. For specialties for which there may be no one practicing in the province, the system can communicate with other sites off-Island. Continuing medical education can be similarly included. An added bonus is that it may be possible to provide access to French or Japanese-speaking care providers for tourists; the latter can be referred to the Nippon Medical Clinic in Los Angeles for a fee. For emergency services, in order to relieve the pressures on local physicians, the potential for a system such as the LifeCom network in Oregon could be explored.

THE ENTERPRISE

The telemedicine service selected for the case study would establish points of presence at the seven hospitals in PEI, and provide clinical consultation service and continuing medical education. Other sites and other services are possible in PEI, but this model reveals the essential issues.

Statement of Purpose

The enterprise would enhance the quality of health care for residents and visitors in rural areas of PEI by providing access to medical education and specialty consultation services at established points of presence throughout the province.

What is the service?

Regularly scheduled consultation clinics in rural areas in selected specialties, such as cardiology, dermatology, allergy, endocrinology, and psychiatry, plus a

series of medical education courses made available to doctors, nurses, and allied health professionals, and lectures for patient education on diabetes, weight loss, smoking addiction, and other topics.

Before setting up the system it will be necessary to analyze the disease burden of PEI and clinical outcomes, and compare different sites on the Island. The telemedicine program should concentrate on strengthening the services and specialties that will have the greatest impact on outcomes.

Who are the customers?

The customers are health care providers and patients in rural areas of PEI.

What is the competition?

The "competition" is the drive to Charlottetown or, for specialists, circuit riding to visit the rural hospitals.

What technologies will be used?

The technologies would include:

- Interactive video with store-and-forward capability, or PC-based facilities, and electronic stethoscope and other suitable peripherals.
- Bandwidth of 384K connection or higher, depending on services desired.
- A program for coordination of services and protocols for consultations, providing standard operating procedures for consistent quality care.

What is the core competency of PEI that makes telemedicine service appropriate?

PEI is an island community with a relatively large rural population and a limited number of specialists. A high speed telecommunications infrastructure is being put in place throughout PEI. The Canadian health care system provides an inclusive network of referrals.

SERVICE REQUIREMENTS

In the absence of a geographically based study of health outcomes compared to care availability, for the purposes of the case study, it will be assumed that the telemedicine POP sites will be sited in the seven hospitals. Public expectations would likely dictate that all hospitals be included in the program. Broad band connectivity is present in all schools and can be installed within one week at the hospitals. An agreement between Island Tel and the Provincial Government speci-

fies a 25% discount on usage fees. Connections of 128K, 512K, and T1 (1.5 M) are available. The school rate for 128K is C$250 per month, with unlimited use. Thus, connectivity will not be a problem.

In each site, the facilities required will be a multipurpose room, with removable seating for about a dozen people, and a place to present a patient for consultations. It should have good lighting; blue walls are somehow considered appropriate for telemedicine. The equipment can either be PC-based or room based ITV. Since the capital cost must be paid up front, the choice will depend on the funds available. An ITV will cost up to C$50,000; the PC will cost much less and can be used for other purposes as well. A PC-based system at 384K bandwidth with ISDN digital transmission will permit transmission of medical records, and with peripherals it can transmit x-rays and EKG. It would not be sufficient for diagnostic radiology, but there are no CT scan facilities in the rural areas anyhow. (That would require a T1 at 10M or delayed transmission.) A large monitor would increase patient comfort, and a good camera will be necessary to show the patient's appearance and full length image as well as close-ups.

There has been no good cost-benefit research on telemedicine published yet. There is a feeling among some PEI physicians that at present the system provides consistent care throughout the province once the patient presents for treatment, but experience in other places shows this perception to be unreliable. Information on mortality and morbidity and a study of outcomes are required to accurately calculate the potential improvement in service and the savings. The telemedicine system would be picking up the cost of transport, now paid by the patients, but it may save in transmitting films and records. For consultations off the Island, the system would be absorbing the patients' much higher cost in travel. Under the Canadian system, inter-province consultations are payable on a province-to-province basis, and a new accounting system must be developed to register telemedicine consultations.

A similar modified system must be put in place for physicians within the Island. Presently, under Canada's one-payer system, physicians receive a fee for service, with an annual cap on fees, and service is defined as a face-to-face visit with a patient. The system must be adapted to count telemedicine consultations under the fee structure, but since there are telemedicine services operating in other provinces, there are probably existing solutions that could be put in place in PEI. A new hospital will shortly be put in service in Summerside, and the telemedicine services could be made a part of it, introducing a new culture and new expectations without having to retrofit old habits.

Medical licensing may be an issue. Must a physician in New Brunswick be licensed in PEI to treat a patient from PEI? Probably not if the patient travels to the other province, but suppose the physician offers his services inside PEI by telemedicine? This will have to be explored.

There will be some ancillary services that will not be maintained within the telemedicine system but must be outsourced to contractors. One of these is tech-

nical support for system maintenance and technology problems through a telephone help desk. Island Tel may be able to set up or find an appropriate contractor.

Another required service will be access to health information and patient records. The provincial government is currently developing an integrated health information system, the Island Health Information System (IHIS). The system will provide patients' medical records on-line to those with a need to know. As one component of IHIS, there will also be a Pharmaceutical Information System (PHIP) that will contain the patients' pharmaceutical record, plus information on counter-indications for each prescription drug. It may be necessary to have a second, separate PC on a separate line in the telemedicine site at the providers' end to access these before or during a consultation.

Telemedicine provides an opportunity to establish a quality case management system. It would be necessary to establish goals, create the necessary infrastructure, and design the treatment protocols. An on-line expert system would confirm diagnoses and make treatment recommendations, but it would be up to the primary care physician to implement them or not. Preparing the protocols for a telemedicine-based case management system could probably be outsourced, perhaps by adopting the protocols for an established system like Kansas, Texas, or LifeCom, or consulting the Canadian Medical Association. The protocols should be focused on telemedicine consultations, but they should be general enough to embrace all medical procedures, designated by area: oncology, pediatrics, etc. Strictly speaking, these protocols are not part of the telemedicine system, but introducing a new methodology is an opportunity to add value and upgrade the entire system.

Aside from the physicians, few people are required to manage the telemedicine system. Most important is the nurse/scheduler at each site, trained to operate the equipment and to present a patient using the camera, peripherals, and other resources. The nurse should also be trained to prepare the patient psychologically for the telemedicine experience and assist in presenting the patient. There must also be a technical specialist to trouble-shoot the system. For most problems, this can be handled by phone by a help desk, provided by a subcontractor.

The equipment and bandwidth at each site would have to be of equivalent or higher capability as that in the central medical centers. High bandwidth connections exist between universities through the Canarie system, funded by the government, so that Dalhousie Medical School will have access to it. For remote consultations, the PEI telemedicine system would connect with Canarie through a fiber leg between Queen Elizabeth Hospital and Holland College. Billings should be treated like a normal consultation, face-to-face, with the cost of the telecommunications connection, if any, added on.

The liability issue is the same as face-to-face, and the same insurers would likely cover the physicians. No new liability issues have as yet arisen for telemedicine consultations. (It is sometimes said that the two best indicators of the

probability of a lawsuit are whether the patient thought the doctor listened and whether the doctor smiled. The doctor's face may not always be visible to the patient during a telemedicine session, but the nurse may listen, smile, and demonstrate concern. In any case, experience shows no higher incidence of lawsuits for telemedicine consultations.)

Marketing will be an important factor in the success of the telemedicine system. There will be marketing to the public, to patients, and to the medical community. Inevitably, however, there will be opposition, with some people seeing not the cost savings and higher quality service, but only the expenditures, and they will measure them by the number of beds that could have been added to the rural hospitals for the same cost. Marketing and education will be very important for gaining public support.

In Kansas, telemedicine enabled rural hospitals to remain open, and this was an important selling point for the rural communities. But people are resistant to change, and it will only come about if the medical community supports it. It should help to reduce the workload of the rural doctors by letting them cover for each other in different centers, especially in emergency room services; it would also expand the reach of the subspecialists. The doctors should be helped to see what's in it for them, and it would help if the Medical Association were positively involved. The continuing education aspect might appeal to the association that supports the licensing regulations.

In the United States, physicians may be motivated by money, time savings, or mandatory requirements. The latter would seem to be out of the question in PEI, as the Cabinet would need to be persuaded that the doctors were in favor before promoting a telemedicine service. The other incentives likewise are hard to mobilize under the Canadian system, since doctors already see as many patients as they can handle and the patients are not permitted to pay out of pocket. But the doctors may have a genuine desire not to be leaving some segment of the population underserved, and telemedicine would enable them to extend high quality coverage throughout the Island. Alternatively, the doctors could be shareholders and share in some of the savings of the system.

Marketing to the public presents a different problem, and this can be done very effectively. The Association of Telemedicine Service Providers provides one model. In an early survey, it was found that most people (including doctors) had never heard of telemedicine, or confused it with telemarketing. Telemedicine is useful only where there is a mismatch between the location of patients and the availability of live care. Measurements must be made of where people are not being served in certain specialties, like cardiology. On a regional basis, the population data can be combined with morbidity and mortality data to estimate telemedicine needs, in terms of time and bandwidth. The community is likely to react to learning the number of cases expected and the care needed in various specialties.

The method can be refined by preparing maps that compare the costs of care,

depending on distance: the distance to the care provider versus the cost of telecommunications. These maps can be overlaid by maps of provider locations, maps of population, and maps of adverse outcomes from particular diseases. They can be linked to a geographical information system for an elegant presentation and put in the public domain or on the Internet. It will show the government the location of the nearest point of service for each specialty: oncology, cardiology, emergency room service, etc., and compare with the distribution of the population at risk. These maps can be prepared as a planning tool for government officials. In the U.S. private health care system, this approach has also proven successful in building public support for telemedicine.

If the public can be convinced, the money could be available from ACOA, from Island Tel, and from the Province, but the project might falter if the medical community does not fully accept telemedicine.

IMPLEMENTATION REQUIREMENTS

Leaders in each rural community should be identified and convened to create a strategic plan. They should encourage the local physicians to clarify their positions with regard to telemedicine. The data gathering and mapping should be initiated to determine and demonstrate the intensity of the need.

A rough cost estimate (in Canadian dollars) includes the following:

- About $40,000 might be needed to install the necessary lines as a one-time expense.
- For each of the seven proposed sites, equipment costs for a PC-based system with the necessary peripheral equipment would be close to $35,000.
- Up to another $10,000 would be required at each site for the physical facilities: room, furniture, paint, etc.
- Connection costs are estimated at about $1,200 per year per site.
- Operating costs would average $500 per month or less per site, including maintenance, licensing, and help desk services.

As with any endeavor, a full time coordinator or change agent will be required to set up the system, and much will depend on the energy and effectiveness of that individual. At each site, a part-time coordinator can be selected to start, and the training of nurses begun. The training will consume about 3 months to learn the whole system, including the computer and telecommunications technology and the practice of delivering health care in a new way. There would be practical exercises in presenting patients for each specialty.

As described above, one of the most valuable benefits of establishing a new telemedicine system is the opportunity to establish protocol-based procedures at the same time. Possibly telemedicine might provide the motivation for this change, but the protocol-based care would in the long term do more for health

care than the telemedicine itself. It is important that the protocols be licensed or developed at the same time that the telemedicine procedures are installed and not be imposed as an afterthought. The Association of Telemedicine Service Providers can provide guidance for testing and evaluation of protocols.

There are several alternatives for funding. ACOA has funds to support information technology initiatives. Human Resources Development Canada may have funds available for training. There may also be a buy-in from Island Tel that would encourage others to join and would leverage matching funds from other partners. The Atlantic Center for the Study of Human Health might be interested in participating in the health care providers' training element.

For partners, there are several groups to approach. Number one should be the physicians, through the Medical Association, and the nurses and other professional groups' representation. Island Tel, the Department of Health, and the Department of Veterans Affairs would represent the service providers and the funders. Finally the consumers' groups and the disease advocacy groups could provide useful public support.