Formal Knowledge Networks

A Study of Canadian Experiences

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ACKNOWLEDGEMENT

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A NOTE ON ISSUES ARISING FROM THIS STUDY

What are formal knowledge networks, and why have they become of such great interest to Canada and to the international development community? In "Connecting with the World: Priorities for Canadian Internationalism in the 21st Century", the Strong Task Force recommended that "knowledge, and the communications and information technologies that can advance knowledge, be placed front and centre in Canadian foreign policy and Canada's international outreach." The Task Force focused on knowledge-based networks as a new approach to sustainable development: helping Canadians at the same time as helping others around the world to share experience and find new solutions to the economic, social and environmental challenges facing us all.

In response to the Strong Task Force Report, IISD and IDRC commissioned a study on "Formal Knowledge Networks—a Study of Canadian Experiences". This is an introductory survey of Canada's evolving knowledge networks. Through this work, we have come to a better understanding of what formal knowledge networks are and how they differ from more traditional information and advocacy networks. We now have basic criteria for their operation, a view of their effectiveness and some real successes, and a new appreciation for their potential for growth and expansion internationally.

Much more work will need to be done to test, refine, and adapt the model for a formal knowledge network as described in this study. In February 1998, representatives of key government agencies, the international development community and the private sector met at IDRC to review the draft findings of this study. A number of issues were tabled, which will need to be taken into consideration if we are to utilize knowledge networking as a necessary and effective tool for sustainable development.

- What first steps might be suggested to link existing Canadian formal knowledge networks with agencies such as IDRC, IISD and CIDA, and through them to their partner countries?

- How can Canada best use or adapt these models of formal knowledge networks to further encourage sustainable development in Canada and its partner countries?

- Since Canada cannot be a world leader in all fields of knowledge creation, how can Canada identify those fields on which it will place particular emphasis in its own formal knowledge networks as well as those which it may create with partner countries? Which issues are central to sustainable development?

- Can scientific knowledge creation and the development of policy options be addressed successfully in a single network? Are the suggested characteristics of a formal knowledge network equally applicable to address science/technology issues and policy-oriented issues? If not, what different characteristics need to be added?

- Do existing institutions, including current Canadian formal knowledge networks, as well as IDRC, IISD and CIDA constitute the best vehicles through which Canada should create mutually beneficial networks with its partner countries? If not, what type of new vehicle needs to be created?

- How can new partnerships for sustainable development, between the research community, policy-makers and government, and the private sector-especially industry and the financial sector, best be created so that they are as seamless as possible, and ultimately self-supporting?

It is our hope that this report will prompt Canadian institutions to pursue the effective implementation of knowledge networks, and further Canada's unique leadership position in the promotion of global sustainable development.

IDRC and IISD would like to thank Dr. Howard Clark, President Emeritus of Dalhousie University, for the significant contribution he has made to this field, through his work and his insight in researching and preparing this report.

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EXECUTIVE SUMMARY

This study on knowledge networks in Canada was commissioned by the International Development Research Centre (IDRC) and International Institute for Sustainable Development (IISD) as part of the follow up to the Strong Task Force report, *Connecting with the World: Priorities for Canadian Internationalism in the 21st Century*. It starts from the recognition that sustainable development internationally and within Canada requires accelerated discovery and application of knowledge, and that Canada is in a unique leadership position with regard to knowledge networks and sustainable development. This report first discusses the characteristics of formal knowledge networks, then investigates the extent to which existing Canadian networks fit this description, and finally offers some overall conclusions and recommendations for action. Descriptions of each of the knowledge networks studied are provided in the Appendix.

WHAT IS A FORMAL KNOWLEDGE NETWORK?

The term "network" is used to refer to a combination of persons, usually dispersed over a number of geographically separate sites, with appropriate communications technology. There are several types of networks:

1. *Informal networks*, which are numerous and come and go, but play a very significant role in the creation of knowledge.

2. *Information networks*, such as university library networks, which provide access to information but do not create new knowledge.

3. *Open networks*, which have a well-defined theme, exist to undertake research and generate knowledge, have formal constitutions, and have invitation-based participation.

4. *Development networks*, which have a well-defined theme and carefully chosen criteria for participation, exist to create knowledge and to accelerate the application of that knowledge to economic and social development, and have a formal constitution and tight governance.

Open networks and development networks can be regarded as formal knowledge networks. Certain ideal characteristics of formal knowledge networks can be identified:

1. their main purpose is to create and disseminate knowledge for use beyond the membership of the network;

2. their structure and operation are designed to maximize the rate of knowledge creation;

3. the network must provide recognizable direct benefits to all participants;

4. there is a formal organization and well-defined management structure;

5. participation is by invitation, based on criteria of merit or peer review;

6. there is a well-developed communications strategy; and

7. the network results in a reduction of boundaries between sectors such as universities and industry.

Additional elements of a formal knowledge network may include:

- culture shifts within institutions towards collaborative activities between institutions and sectors;

- multidisciplinary, multisectoral and multi-national/regional in terms of both network participants and in audience;

- better relations with funders such as industry and government;

- strong involvement in graduate education and training (over 50% of networks surveyed);

- typically, networks produce knowledge at a faster rate than otherwise possible;

- cost effectiveness in operations, and possibly revenue generating through sales of products; and frequently mobilization and/or more efficient use of human resources;

- more effective influence on decision-makers through size of network, reputation of network members and quality of collaborative work – this is maintained through a careful balance of management and degree of selectivity;

- international scope, either potential or actual (73% of networks surveyed), reflecting the reality that knowledge networks cannot isolate themselves from what is going on elsewhere;

- knowledge networks can make a considerable contribution to sustainable development.

Interviews were conducted with four CIDA Centres of Excellence, 12 Networks of Centres of Excellence (NCEs), the Canadian Institute for Advanced Research (CIAR), the Canadian Policy Research Network (CPRN), ORBICOM, the Canadian Global Change Program (CGCP), the Canadian Network of Toxicology Centres, CANARIE, IDRC, and several NGOs. The NCEs most

closely match the ideal description of a formal knowledge network and were deemed to be significant, even if they are not known well as a Canadian success story. Nine conclusions can be drawn from the analysis:

1. The NCEs have produced a remarkable and rapid culture shift among researchers, promoting collaboration both among researchers and between researchers and industry.

2. The relationship between industry and academic researchers is becoming more constructive and industry is funding more research.

3. NCEs produce knowledge at a faster rate than would otherwise be possible.

4. Most NCEs are cost-effective.

5. NCEs allow the mobilization of scarce human resources to tackle problems beyond the capacity of existing institutions.

6. Formal knowledge networks can make a considerable contribution to sustainable development.

7. NCEs are multidisciplinary and multisectoral, transcending barriers.

8. NCEs provide a superior environment for training graduate students and fellows.

9. Most of the above attributes are derived from the careful balancing of management with degree of selectivity; NCEs generally follow a corporate style of operation and management, combined with discipline and willingness to innovate.

Some of the issues that remain to be addressed in the NCEs include: the need for many formal knowledge networks to develop a well-defined communications strategy; the need to include the financial sector more fully, if possible from the outset, as industry is now, in order to support the sustainability of the network and accelerate the economic benefits; and the need to create new NCEs in a diverse range of fields.

Canada's development of formal knowledge networks is a result of 15 years of experience and is, therefore, based on a considerable depth of thought. Many of the features that seem to be contributing to the success of the NCEs were originally developed for the creation of CIAR, or reflect lessons learned from its operations. Other networks such as CGCP and CPRN match the description of formal knowledge networks but differ from NCEs in that they focus on policy rather than on marketable products. It is difficult to measure the success of these networks, as there is no direct link to revenue from products developed. Ultimately, their value is determined by the network's credibility and reputation established over time.

The Canadian Network of Toxicology Centres also closely resembles an NCE in structure and management. Many of the issues it deals with are applicable internationally and have significant implications for sustainable development. Links could be forged between this network and other development-oriented networks. CANARIE, which is similar to an NCE, has considerable importance in helping to maintain Canada's expertise and leading position in telecommunications and networking. Development organizations should maintain some link with CANARIE.

The CIDA Centres of Excellence lack many of the characteristics that contribute to the success of the NCEs. They resemble informal networks, likely to survive only as long as the interests of the participants are compatible. However, the Centres have made a valuable contribution to graduate education.

IDRC networks generate knowledge and disseminate it widely; however, IDRC's network model could benefit greatly from linkages with new developments in knowledge networks in Canada. ORBICOM does not really fit the description of a formal knowledge network, since it has been established as an apolitical, neutral organization open to all streams of thought and opinion.

Information on NGO networks was obtained from Friends of the Earth, Greenpeace Canada, Mines Action Canada, and the International Federation for Red Cross/Red Crescent (IFRC). The IFRC is a good example of the difficulties of building a knowledge network that includes both developed and developing countries in the NGO sector. Greenpeace matches the description of a formal knowledge network in most respects, (e.g., it has a well-defined structure, generates new knowledge, and has a well-defined communications strategy). Friends of the Earth is similar. The success of Mines Action Canada in creating change is notable, but for the purposes of this study it does not really qualify as a formal knowledge network, as its roles are almost exclusively advocacy and raising public awareness.

Three observations can be made before concluding. First, there seems to be a feeling that over the last two decades the universities in particular have been weakened financially and academically. The creation of formal knowledge networks has impacted negatively on the traditional structure of the university as a community of scholars. Second, as the Strong Report pointed out, sustainable development in Canada cannot be separated from global sustainable development. There is a need to refocus Canadian efforts in knowledge networking to reflect this reality. Finally, there is tension between public good and proprietary knowledge, or the wide dissemination versus the application of new knowledge. This has implications for the stable funding of policy oriented networks which will need to find new ways to involve the private sector.

Canada is in a most advantageous position in its development and application of formal knowledge networks. Some existing networks already contribute to sustainable development in Canada, but many new networks should be established if Canada is to benefit from our current competitive lead. A fundamental objective for new networks should be to contribute to sustainable development in a specific, defined way—first in Canada, but ultimately internationally.

The report recommends the following actions:

1. Canada should officially adopt the recommendation of the Strong Task Force that knowledge, and the communications and information technologies that can advance knowledge, be placed front and centre in Canadian foreign policy and Canada's international outreach.

2. Canada should act with regard to the above recommendation with considerable urgency.

3. IDRC and IISD should urgently undertake jointly the development of mechanisms that will keep them informed about existing formal knowledge networks in Canada, and in appropriate cases should create formal partnerships.

4. Where appropriate, all Canadian development agencies, including but not restricted to CIDA, IDRC and IISD should engage Canadian formal knowledge networks in partnerships and other forms of development activities.

5. IDRC, IISD and CIDA should, on an urgent basis, convene a small working meeting to consider:

   a) appropriate mechanisms whereby existing Canadian networks can be fully integrated with international sustainable development activities;

   b) the possible creation of several new formal knowledge networks relating to aspects of sustainable development; and

   c) the broad focus of these new networks, as well as their structure and management.

INTRODUCTION

Late in 1995, a Task Force was established by three eminent Canadian development institutions, the International Development Research Centre (IDRC), the International Institute for Sustainable Development (IISD), and the North-South Institute (NSI). These three organizations have, over the years, supported and extended Canada's role in the world and ensured its leadership in promoting new patterns of sustainable development.

The Task Force was asked to explore Canadian capacity in international development research and policy. Maurice F. Strong chaired it and published a report in November 1996 under the title "*Connecting with the World: Priorities for Canadian Internationalism in the 21st Century*". The Report (known hereafter as the Strong Task Force Report) recognized that Canada has established a position of leadership and respect in international development through the work of bodies such as the Canadian International Development Agency (CIDA), the three sponsoring bodies for the work of the Task Force, and many other government and non-government organizations. Canadians rightly take pride in the significant contributions their country has made to international development; indeed this pride in Canada's generosity and concern for the underprivileged is a significant part of the Canadian identity.

Sustainable development is a concept which gained prominence through the work of the Brundtland Commission in the late 1980's, and was the unifying theme of the Earth Summit in Rio de Janeiro in 1992. Many Canadians and Canadian organizations have now committed themselves to the cause of sustainable development, both globally and nationally. The concept, however, is complex and involves the integration, or intersection, of economic development, environmental protection and preservation, and social development which enhances the quality of life and well-being of the individual. The appropriate balance of these different facets of sustainable development is delicate, and probably variable according to the different stages of the development process. But all facets are essential, and all must be encouraged by appropriate mechanisms, which will be increasingly knowledge-based.

Since the Strong Report is widely available, its conclusions and recommendations do not need to be re-stated here. However, there is an extremely important observation in the Report that is fundamental to this present study and which, therefore, needs to be re-emphasized. There are two distinct facets to this observation: first, the Strong report points out that the absolute numbers of those without the most basic of human necessities is actually increasing and that international development will have to be significantly transformed if it is to deal successfully with the new realities and emerging problems. Development

will increasingly entail the generation, acquisition, dissemination, and application of new knowledge, and will place less emphasis on direct financial assistance. Second, Canada's relative capacity to contribute in future to international development is seriously at risk. Within 25 years, Canada will no longer have a place among the world's top seven economies; it will not even be among the top 15. Within 25 years, nine of the top 15 economies will be those of countries we now think of as "developing", and 17 of the world's 20 largest cities will be in the South. Canada itself, therefore, will have "to earn its way internationally, in large part through its intellectual capacity and policy leadership, through broad-based intellectual partnerships, transnational policy inquiry, and our mastery of new technologies."

It is increasingly recognized that Canadian development will require substantial investment in knowledge and Canadian capacity, together with the creation over time of direct working relationships with other countries. An entirely new approach to personal interchange is needed; one based on partnerships aimed at seeking solutions to common problems.

The Task Force observed that sustainable development is a critical issue for all countries, including Canada and developing countries. This issue will require much re-thinking of policies by those accustomed to involvement in the international development assistance, or "aid" field. Aid and sustainable development must be fully integrated, with economic and social growth occurring in Canada as well as its partner countries. Canadians will need to recognize that the greatest potential markets for Canada in the coming century lie in developing countries, and that the growth of Canada must accompany the growth of our partners.

Canada can be a strong partner with these "developing" countries in their efforts to become part of a larger world economy if it is able to strategically position itself around issues relating to knowledge and communications for sustainable development. Increasingly, then, partnerships of the future will need to contribute to Canadian development as well as the development of our partners.

As a first step in follow up to the recommendations of the Task Force, this study was commissioned to report on formal knowledge networks existing in Canada. This report is not complete but rather an introduction to some of the existing Canadian formal knowledge networks. However, a sufficient number of such networks in a variety of fields have been examined to illustrate clearly how formal knowledge networks can contribute to sustainable development.

This report discusses the characteristics of a formal knowledge network, the extent to which existing Canadian networks fit this description, and finally some overall conclusions, and suggested actions. The attached Appendix provides a description of each of the networks that was visited, together with comments that arose from interviews. To gain full understanding of Canada's experience with formal knowledge networks, a careful review of the Appendix is essential.

FORMAL KNOWLEDGE NETWORKS

When this study was commissioned, no definition of the term "formal knowledge network" was provided, so it is important to begin with some consideration of the term, to attempt to describe the characteristics of these networks, and to define the term as it will be used in the remainder of this report.

Networking and networks are not new. Networking is often used to describe a process in which two or more people communicate back and forth to each other; a network can consist of people or linked communications technologies; it can be in person or through linking computers; or it can be both, a combination of people with communications technology. All of these and other definitions of networks are valid, but in this report, the term "network" will refer a combination of people, usually dispersed over a number of geographically separate sites, with appropriate communications technology. Approximately the same emphasis will be placed on the human aspect as on the technology; they are equally important.

It is readily apparent that, over the last 40 or so years, a number of different types of networks have come into existence. The most common are the informal networks; it is impossible to estimate how many of these exist, but the number must be in the hundreds of thousands, if not in millions. Two or more individuals just as a convenient and quick means of communication can create such a network; it may be for conversation, for exchange of information, or allow for discussion to create new knowledge. However, the existence of this new knowledge will remain hidden within the network and, therefore, inaccessible, unless steps such as publication are taken to make it freely available. Participation in such informal networks is purely voluntary; there is no formal organization of the network, and participation in it will wax and wane with the level of interest of the participants. Many informal networks are created and die within a very short time, often because the need for the network has been met and its existence is no longer necessary. In other cases, the demise of the network may be because the apparent need was not real, or the purpose in creating it was not sufficiently clear or was not understood. However, it must be very clearly recognized that informal networks are exceedingly numerous, constitute by far the largest category of networks, and do indeed play a very significant role in the creation of new knowledge. It is nevertheless an impossibility to provide a catalogue of informal networks, or to list the contributions they make to new knowledge. The scope of this report will thus be limited to formal networks.

The second type of network that can be differentiated is that which provides access to information. The university library networks provide good examples. A university library network, in Ontario for example, provides access to all information in the libraries of the university system. It is a formal network in that its constitution, management, mode of operation, and finances have been carefully documented and formally approved by the participating institutions. However, the network itself is passive; it provides access to information, but each person has to come to the network, physically or electronically, and participate. This type of network does not usually create new knowledge, although as digital libraries come into use in Canada this may change. A digital library, in addition to providing access to information, allows for some manipulation of data and information, so that the development of new knowledge may occur. Again, however, its creation and existence will remain unknown unless steps are taken to disseminate it.

The third type of network can be referred to as an open network. These come into existence more slowly and require the thoughtful development of a well-defined theme. The network may exist to undertake research, to generate new knowledge in a specific area of science and technology, or to engage in research on various options of policy issues. Participation in an open network is by invitation, based on the academic excellence of a researcher, or a match of qualifications with the nature of the policy research being undertaken. For policy-oriented open networks, wide dissemination of the research results is necessary if the work is to be credible; science-oriented open networks also publish widely. Since open networks are concerned with closely defined themes, they have formal constitutions, hold annual meetings, and place specific responsibilities on participants. Finally, it is important to emphasize that these open networks are created and driven purely for the purpose of creating new knowledge; there are no concerns about possible applications or development, beyond the responsibility to make new knowledge available through publication or other means.

The fourth and final type of network can best be referred to as a development network. These networks are focused on a well-defined theme under which a variety of specific projects may be undertaken. The participants and/or projects are carefully chosen by peer review using criteria based on excellence although, however good the researcher, participation in the network may cease at the conclusion of a particular project. The network exists to create new knowledge, but also to accelerate the application of that new knowledge to economic or social development. The network has a tight form of governance, a formal constitution, and a more hierarchical structure. Since in many cases economic development is accepted as a major objective, the issue of ownership of intellectual property can become important, although this does not necessarily retard the placing of new knowledge in the public domain.

From the above descriptions, it will be clear that only open and development networks can be regarded as formal knowledge networks, since only in these is there a clear objective of creating and disseminating new knowledge. But this in itself can hardly be regarded as a sufficient definition, especially in terms of the essential role that formal knowledge networks are likely to play in sustainable development in future. At the present time, and recognizing that such concepts and definitions will undoubtedly evolve with greater experience, it seems that the ideal formal knowledge network will have the following characteristics:

(i)   The Network exists for the purpose of creating and disseminating new knowledge; it does not exist just to provide access to existing knowledge, nor is new knowledge retained for the use of the network but is made publicly available as quickly as possible.

(ii) The Network is structured and operates so as to maximize the rate at which new knowledge is discovered. This is essential for a Network dedicated to issues of sustainable development. If the rate of creation of new knowledge is not maximized, the gap between developed and developing countries will be extremely difficult to reduce.

(iii) The Network must provide clear, recognizable, and direct benefits to all participants in the Network.

(iv) The Network is formally organized, and has a well-defined constitution and management structure.

(v)   Participation in the Network is by invitation based on criteria of merit, or by peer review of proposed projects.

(vi) The Network has a well-developed communications strategy.

(vii) The Network should transcend boundaries between various sectors (e.g., university, researchers, industry, financial, government) to contribute to sustainable development.

Some amplifying comments are warranted on the above characteristics. With regard to the first, little need be said other than to point out that dissemination of new research results does not inhibit economic development; commercialization of research and publication can proceed virtually simultaneously. Moreover, as the Strong Report emphasizes, sustainable development in Canada must, by definition, involve economic development; without it, Canada will be unable to form effective partnerships with other countries.

The speed of discovery is now as important as the fact of it. In the past, networking by organizations such as IDRC has certainly provided more rapid access to existing information, but this has been far surpassed by the even more rapid development of new knowledge and knowledge-based industries in developed countries. Sustainable development, especially in the less developed coun-

tries, requires accelerated discovery and application of new knowledge, and this in turn requires new structures and new partnerships. Ample Canadian experience, some of it described here, shows that a network will be successful only when each participant can see a direct benefit. For the researcher, this may be in the form of additional research money, or it may be the intellectual excitement that the network generates; for an industrial participant, it may be the prospect of a new profitable product.

There is also ample Canadian experience to demonstrate that two other aspects of formal knowledge networks are critical to success; these are management of the network, and the degree of selectivity exercised in the choice of network participants. A highly focused network requires tight management if it is to produce significant credible new knowledge rapidly, especially where economic development is an objective. However, in networks that are concerned with policy issues or where the driving motivation is just the intellectual excitement of new knowledge discovery, periodic evaluation, preferably by internationally recognized experts, resolves management issues. In policy networks it is the degree of selectivity in the choice of participants, which is important, since it creates a team approach and encourages the researchers to feel that they belong to an elite group. Such elite networks are not open to anyone; the criteria for membership are based on high standards, which need to be applied rigorously and consistently. As will be seen from the Appendix, the most successful Canadian networks have carefully balanced the goals and objectives of the network with the firmness of management on the one hand and the degree of selectivity on the other.

The need for a well-developed information technology and communications strategy is also important. There are several aspects to this. First, on the technical side, formal knowledge networks need to maintain strong links with research and development in telecommunications and computing. A successful network will be aware of new communications technologies and will be prepared to adopt them as soon as possible to maintain a competitive edge. For example, it seems certain that Internet II (A new layer on the Internet that allows high-speed access (up to 1000 times faster) to universities and other institutions) and the new generations of video-conferencing will have profound impacts on the way in which networks operate in future. If existing networks are not aware, in advance, of such developments and prepared to make innovative use of them, they will lose their competitive edge. On the other hand, in partnerships with developing countries, it cannot readily be assumed that there will be the same level of access to communications technologies as in Canada. There are currently networks based on Canadian institutions partnering with sister institutions in several different developing countries in which it is still not possible to use the Internet or even e-mail. Second, a sound communications strategy will take into account the relationships of the network with all stakeholders, includ-

ing the Canadian Public. It will have a well-conceived plan to keep stakeholders aware of the accomplishments of the network and of its ongoing program. This plan should be based on demonstrating the contributions the network makes to sustainable development.

Finally, sustainable development for Canada and other countries will increasingly depend on not just new knowledge discoveries, but more on how rapidly they can be applied to economic, environmental, and social development. In the past, valuable new knowledge lay idle for years largely because the boundary between the university researcher and industry was impenetrable, or because industry did not have or retain the confidence of the financial sector. For rapid, successful sustainable development, these barriers must be reduced. This study of existing Canadian networks provides clues as to how this might be achieved. Not all knowledge networks aim to convert knowledge into marketable products—for example, networks in the fields of human rights or the environment are trying to convert knowledge into policy.

The above description of the characteristics of an ideal formal knowledge network will certainly evolve with greater experience. It is not intended to suggest that there now exist in Canada networks that completely match this description—none do. On the other hand, there is good reason to conclude that Canada is much closer to matching this ideal description than perhaps any other country and that our experience to date, together with other factors, place us in a leadership position in the application of formal knowledge networks to sustainable development. Many of these other factors are reflected in the history of development in Canada, and in the evolution of values which are now important to Canadian society. Also, Canada is viewed as one of the leading countries in terms of both its concerns and its actions on environmental issues, although we continually struggle to find the appropriate balance between economic development and likely environmental outcomes.

Thus, sustainable development, as defined earlier, is well reflected in Canada's economic history, in our social values and concerns for social well-being, and in Canadian attitudes towards environmental preservation. We provide an excellent example of a country struggling to achieve sustainable development. Of course, the term "sustainable development" has been created only recently and cannot convincingly be applied retroactively. And, of course, Canadian development has been far from perfect and many issues remain unresolved. Economic development through the private sector has all too often been totally self-interested; government intervention has not always been either timely or appropriate or efficient; social programs that support our quality of life are neither complete nor perfect; and all Canadians recognize that, at best, only a mere beginning has been made in addressing critical environmental issues.

Nevertheless, Canada is in a unique leadership position with regard to sustainable development. Our history and past actions unambiguously establish this,

as does our participation over the past half-century in international development. We have been through many of the early phases of sustainable development, albeit imperfectly and only very recently have we moved further to a technology-based economy, and now we are entering the knowledge-based era. However, the unique and quite remarkable opportunities that now lie ahead for Canada, in terms of both its own continuing sustainable development and that of its partner countries, have as much to do with Canada's very recent and potentially very successful creation and use of formal knowledge networks over the last decades. The remainder of this report will be devoted to a description of many networks, and of lessons learned from them. But it is the confluence of all of the above factors: Canada's history, our continuing concerns for society and quality of life; Canada's leading role on many environmental issues; our concern for the less fortunate and our major contributions to international development, now to be combined with our leading capabilities with formal knowledge networks, that creates unprecedented opportunities and challenges for Canada.

CANADA'S EXPERIMENTS AND EXPERIENCES

At the commencement of this study, it was suggested by the two sponsoring organizations that an appropriate starting point might be to examine the Centres of Excellence funded by CIDA, and the Networks of Centres of Excellence (NCEs) funded through the three federal granting councils.[1] CIDA Centres were established in 1990 for a five-year period often extended to seven and the NCEs in 1989, initially for a four-year period. Six CIDA Centres were created and initially 15 NCEs: in 1994, after thorough review, 10 of the NCEs were renewed for another four year period and four new NCEs were created. At the time of writing this report, 10 of the 14 NCEs were awaiting decisions about further four-year renewals. Interviews were conducted with four of the six CIDA Centres, and with 12 of the NCEs. Additionally, interviews were conducted with:

- Canadian Institute for Advanced Research which has established eight networks;

- Canadian Policy Research Network which consists of three research networks;

- ORBICOM which is a world-wide network of UNESCO Chairs in Communications;

- Canadian Global Change Program which is a network operated by the Royal Society of Canada;

- Canadian Network of Toxicology Centres; and

- CANARIE (Canadian Network for the Advancement of Research, Industry, and Education).

In addition, a number of interviews were held with IDRC staff since that organization has had considerable experience in networking. In all, discussions were conducted concerning at least 35 networks administered through approximately 23 organizations. As well, information was obtained concerning the networks of a number of non-governmental organizations. Nearly all organizations provided printed material, usually including a recent annual report, to supplement information obtained in the interview. In addition to these, discussions were

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1 The three granting councils are: the Natural Sciences and Engineering Research Council (NSERC), the Social Sciences and Humanities Research Council (SSHRC), and the Medical Research Council (MRC).

also held with several researchers directly involved in NCEs, and also with several representatives of the venture capital sector.

The first observation to make is that each network is different: there is no single description that will fit them all. For this reason, the Appendix has been compiled to provide details of each, as well as comments on major issues covered in each interview. Having said that, there are clearly some networks that stand out above others; these include most of the NCEs, the networks of Canadian Institute for Advanced Research (CIAR), and the Toxicology (Canadian Network of Toxicology Centres) network; indeed, allowing for some differences between them, it is the NCEs that most closely match the ideal description of a formal knowledge network.

For this reason, it is important to give some details of the Networks of Centres of Excellence Program, especially since there has been some modification of the initial objectives. Currently, the four objectives of the Program are:

- Stimulate leading-edge fundamental and applied research in areas critical to Canada's economic development;

- Develop and retain world-class scientists and engineers in essential technologies;

- Manage multidisciplinary, multisectoral, national research programs that integrate stakeholder priorities through partnerships; and

- Accelerate the exchange of research results within the networks and accelerate technology transfer to users for social and economic development.

An NCE Directorate representing the three granting councils and Industry Canada administers the Program. Management and evaluation of the Program are rigorous, with the latter fundamentally based on the quality of the research that the Network produces. The last major evaluation of the complete program was conducted in 1996 by an independent consulting company. The Report issued in January 1997 indicates that, in virtually all respects, the Program has been remarkably successful. However, it must be remembered that in 1996, the NCEs had existed only for six years, and that a fully reliable assessment of the contribution they make to economic and social development probably cannot be conducted for at least another five years.

In brief, each NCE consists of a number of researchers, usually in the range of 30-100, drawn principally from universities across Canada but in some cases including researchers from government and/or industry. These are the members of the NCE. Each NCE has a number of industrial affiliates, often in the range of 25-75, who are expected to benefit from the research of the NCE and also ultimately to support it financially. The selection of members is made carefully, often based on peer evaluation. A Board of Directors, of which a substantial

number are drawn from the business sector, manages each NCE. There is also a Scientific Council, quite separate from the Board, which determines the overall scientific directions of the NCE, determines the quality of what is being done as well as its potential for economic development, and generally monitors the work of members. Each NCE has a Scientific Director who co-ordinates all research activities; most now have a separate position of Executive Director or Network Manager, as well as a Technology Transfer Manager, and a Communications or Network Manager. Each NCE is formally constituted with a written constitution, many are now incorporated as non-profit corporations, and some have very comprehensive and useful Members' Agreements. Each NCE is required to hold at least an Annual Meeting and to publish an Annual Report; most also hold several other meetings during the year which are science-based and sometimes restricted to members.

Taking into account the ARA Consulting Group Inc. Report, together with points covered in interviews and in a variety of print materials, the following conclusions can then be drawn:

I.   The NCEs have already produced a remarkable "culture shift" among the networked researchers. One of Canada's best scientists stated that "when I first became involved in the network, I thought that the network would just be another source of funding, and that I would just continue with my research program as planned. That is not how it has turned out. Because of the network and the quick interchange of ideas and results that it allows, my research is now moving in totally different, unexpected, and collaborative directions."

In interview after interview, researchers again and again referred to the culture shift that the NCEs have produced. The term "culture shift" was used in at least two different senses. First, everyone interviewed confirmed that the networks have convinced researchers of the benefits of collaboration, set against a past in which most researchers worked in isolation. Collaboration leads the research quickly in new directions and, perhaps more importantly for a mid-sized country such as Canada, gives a critical mass of researchers that can compete globally. The "culture shift" is also used to refer to the fact that the NCEs have made the researchers far more aware of industry's problems and needs, and has led to much more industry-oriented research.

It is absolutely remarkable that the NCEs are producing this culture shift, a very considerable Canadian accomplishment. Over the last 30-40 years, a variety of government programs have been introduced in attempts to diminish the barriers between academic research and industry, but with at best very limited success. The NCEs are achieving a major reduction in those barriers, and hence much more rapid and efficient transfer of new knowledge into faster economic development. At this point, it also needs

to be emphasized that the NCE Program is not only concerned with marketable products and economic growth. Six of the present 14 NCEs are in health-related areas, and are, therefore, just as concerned with improving the quality of life as with contributing to economic development. The NCEs, therefore, contribute to sustainable development in Canada and can ultimately do so worldwide.

II. The relationships between industry and academic research are becoming positive and constructive rather than isolationist and even confrontational. This is largely a result of the inclusion of representatives of interested companies at the establishment of some networks. The industrial representation has over time increasingly influenced the direction of research, but there is no evidence that this is causing any degree of discomfort among the academic researchers who still consider themselves working in fundamental research driven by the imperative of open publication. Industrial representation has also influenced for the better the manner and style of management of the NCEs. Most important, however, is the fact of the increasing and substantial private sector financial contributions to NCEs. Many can demonstrate that this support is now far in excess of the NCE Program funding, and many confidently believe that over the next 7-8 year period, they can each become financially self-supporting based on industrial funding together with funding received from commercialization of research results. Certainly there has been no prior history of substantial industrial financial support for Canadian research.

III. There is very clear evidence that the NCE produces new knowledge at a far faster rate than would otherwise be possible. Collaboration and the rapid exchanges which modern technologies make possible are the principal components that produce this increase. This is evident in the rapidly increasing number of scholarly publications from the NCEs, the great majority of which are now multi-authored from several institutions within the network. Not surprisingly, given the above comments, both the rate of technology transfer as well as the quantity of such transfers are also vastly increased. For example, one network in existence since 1989 already has had 25 patents issued to it with another 50 patent applications pending. Several other networks state that they have already created a number (usually between five and 10) of separate spin-off companies and can attest to a significant number of jobs created.

IV. Not only do knowledge networks such as the NCEs lead to a more rapid rate of discovery, they also allow the mobilization of scarce human resources to tackle problems that are complex and often cross-disciplinary, and which frequently cannot be addressed within existing institutions. These networks can allow the creation of interfaces between basic, applied, and development research in ways that produce a more effective

and efficient synergy. They provide the capacity to move forward, at a relatively low cost, complex intellectual fields that are central to building understanding and capacity for sustainable development.

V. The evaluation report of the ARA Consulting Group Inc. clearly indicates that the NCEs are cost-effective. To quote from that report: "the discounted, deflated, projected net benefits from just nine "big winner" projects are anticipated to more than cover (by $34 million) all program and partner costs to date, as well as all future commercialization and production costs for those nine projects". Few other government-supported programs, if any, could make such a claim.

VI. Some examples of the outcomes of NCE research may be useful in demonstrating likely contributions to sustainable development. The Canadian Genetic Diseases Network, which has already formed four new commercial undertakings, is responsible for discovering the two genes that cause early-onset Alzheimer's disease. The Sustainable Forest Management Network asserts that either universities or industry alone would never have conducted the research it is conducting, and that the Network is exerting a considerable influence on industry and industry values with regard to sustainability. The Canadian Bacterial Diseases Network conducts research on many bacterially-caused diseases, including many that are prevalent in less developed countries. It expects to produce a variety of new antibiotics and vaccines. TeleLearning is working with four technologies that have the potential to become the software environments within which technology-based education and training will take place in the future. While these examples have been carefully selected, they nevertheless demonstrate clearly the considerable impact that formal knowledge networks can have on sustainable development.

VII. The NCEs are indeed multidisciplinary and multisectoral. They have been able to transcend the departmental and disciplinary barriers that exist in Canadian universities in ways that have previously not been possible. This is, again, a substantial achievement; universities are not noted for the ability or speed with which they embrace change, yet the NCEs seem to have successfully surmounted this. As an example, the Sustainable Forest Management Network links natural scientists in forestry, soil sciences and biological sciences with social scientists in economics, sociology, anthropology, health sciences, law, political science and environmental, civil and chemical engineering—and it appears a success. Essentially all of those interviewed placed a high value on the degree of multidisciplinarity that the NCEs are achieving.

The fact that the NCEs are multisectoral is evident in that each is required to have a number of industrial affiliates and each has a Board of Directors

which in some cases has a majority of industrial members, together with academic and perhaps government members.

VIII. The NCEs provide a very superior environment for the training and education of graduate students and post-doctoral fellows. This is viewed as one of the major strengths of the NCEs. Compared with the pattern that has been customary in Canadian universities over the past 50 years whereby a graduate student has usually had one supervisor, studied in only one department, and has known just one university, NCEs provide a multidisciplinary environment in which the student may be associated with several senior scientists in a number of different departments, and often at two or three different universities. Moreover, throughout the period of graduate study, the student is in contact with representatives of industry and often of government laboratories, and graduates with a considerably better understanding of applications in the field. For students who have graduated after studying in an NCE, the record of employment opportunities in Canada appears to be excellent.

IX. Many of the above attributes of the NCEs are derived from the careful balancing of the nature of management on the one hand, and the degree of selectivity on the other. The NCEs were created to follow a corporate style of operation and management, and they all do so to a greater or lesser extent. In all of them, however, the corporate model imposes a discipline and a willingness to innovate that is not evident in some other networks. There is, for example, a world of difference between an NCE and a CIDA Centre of Excellence: the latter usually represents a continuation of previous research interests with little direct pursuit of possible applications, and little if any discipline is exercised on the members. In NCEs, the role of the Board is not perfunctory, nor is it just advisory. In most cases, the Board of Directors functions as a genuine corporate board although some are more proactive than others. This corporate model imposes discipline on all aspects of the NCE's operations; researchers are expected to provide regular reports, to meet deadlines, and to achieve agreed-upon goals. While there may be criticisms about the use of this corporate model in the university setting, the compelling argument in favour of it is that the world of the 21st century requires the application of new knowledge to sustainable development as rapidly as possible; the old paradigms are no longer applicable.

Some NCEs were incorporated at an early stage, others have delayed that decision until very recently, and still others are undecided. Those that have incorporated have done so as non-profit corporations usually for arguments that are legal, or that relate to the issue of ownership of intellectual property. The most thorough example is that of PENCE (see Appendix) which has put in place an excellent and very comprehensive Member's Agreement; this is almost certainly

the best such document currently available and should be carefully examined by those interested in formal knowledge networks. Closely related to the nature of management of the NCEs, is the issue of selectivity of participants. Formal knowledge networks function successfully in large part because participation is restricted. The restriction may be exercised in the form of a limited number of invitations to join the network, or it may be in the form of an open invitation for the submission of project proposals under a specified theme, with the final selection being based on rigorous peer evaluation. This careful selection, and of course the rewards that it can bring in the form of NCE funding, encourage the participants to accept a degree of discipline that university faculty members would not otherwise tolerate.

All of the above conclusions speak very positively about the potential of formal knowledge networks to advance sustainable development, but it would be misleading to encourage any perception that Canada has all or even most of the answers. There are issues that remain to be addressed; some are:

I.   Many of the NCEs and other formal knowledge networks do not have a communications strategy. Some are entirely preoccupied with research progress so that while they make use of various forms of telecommunications as well as the Internet, these are regarded just as convenient tools, as was the telephone in previous decades. There is insufficient sense of the importance of communications in itself, both in terms of developing new technologies and of relations with stakeholders. The fact that the NCEs are presently a well-hidden Canadian success story just emphasizes the inadequacy of the existing communications efforts. In fairness, it must be stated that a few of the NCEs are taking this issue very seriously, that some have themselves networked with communications networks (e.g., CANARIE) and that the communications strategies they now have in place constitute a good start. However, in general, much more needs to be done in this area.

II.   Rapid and efficient economic development requires a seamless link between industry and the research community. Clearly, the NCEs have made great advances in this area. The next steps, however, require more complex arrangements that must involve co-operation between researchers, industry, and the financial sector, and these links also need to be as seamless as possible. The NCEs have not yet shown that they can successfully address such issues but they have certainly taken the first steps. Ideally, the financial sector should be fully involved from the outset of the network, as the industrial sector is now. However, a research outcome with commercial potential cannot be described in advance and, therefore, nor can the nature of the appropriate relationship with the world of finance. PENCE has taken the step of requiring constitutionally that its Board of Directors always includes a representative of the financial

sector, but alternative approaches also need to be sought. For example, on a regional basis, NCEs might collectively mount annually a "show and tell" demonstration to selected representatives of the financial community; especially those involved in venture capital organizations.

Apparently, in the early years of the NCEs, one venture capital company did attempt to develop a Joint Venture Agreement with one of the NCEs, but since this would require giving exclusive rights for commercial development to the venture capital company, it was not acceptable to the other NCE industrial partners.

III.   New NCEs need to be created in a diverse range of fields. At present, six of the 14 (before decisions were announced for Phase III) are in health-related fields, one environmental, one in education/human development, and the remaining seven in science and engineering fields. Indeed, an examination of all Canadian network experience shows that the largest number has been associated with the health and health-care fields. New networks should be established in other fields, (e.g., relating to environmental issues or in fields that relate to social and quality of life matters). Essential to every case is:

- the theme or subject area of the network be carefully and fully defined and agreed upon before the network comes into existence;

- the principle of selecting only the very best participants through a rigorous peer review process must be strictly observed. For Canada to develop effective partnerships for sustainable development with other countries, it is essential for Canada to demonstrate careful selection, and thus to show that Canada is putting its very best expertise in a particular field on the line.

- the network has a firm line of management with clear accountability including deadlines; discipline must be exercised but intelligent leadership is equally important.

The challenge of building on the NCEs and of expanding them into other areas of sustainable development is formidable but possible, and Canada is already at the forefront. Canada should consider which sustainable development issues it is best positioned to deal with through Canadian knowledge networks, and which are better addressed through support of international or developing country networks.

To conclude this discussion of the NCEs, it is important to sketch some of the history that has brought Canada to its present leadership position with these formal knowledge networks. There is no doubt that the central figure is Dr. J. Fraser Mustard, who, in 1982, established as a private sector initiative, the Canadian Institute for Advanced Research (CIAR). "The unique mission (of

CIAR) is to mobilize and focus the knowledge resources of a vast and thinly-populated country into an international network of extremely talented individuals working in intellectually demanding fields." Considerable forethought was devoted to the development of each research theme, and the limited number of participants was very carefully selected by criteria based on international excellence.

The guiding principles of CIAR are: intellectual excitement, fundamental inquiry, and high quality international standards. No attention is given to immediate economic application; the subject themes have been selected purely for their current importance in intellectual inquiry, although also coupled with the fact that they are multidisciplinary in nature. From its inception, CIAR stressed the importance of partnerships among universities, governments, and the private sector; in other words, CIAR creates and maintains formal knowledge networks in a number of areas (see Appendix).

The present annual budget of CIAR is approximately $10 million of which about one third is from the federal government and the rest from private sources; CIAR is very much a non-governmental research institute.

Many of the features that seem to be contributing to the success of the NCEs, were originally developed for the creation of CIAR, or reflect lessons learned from its operations. The recognition that knowledge networks of this type, which carefully marshall the very best expertise in Canada into Canada's virtual research centres, and thus overcome the limitations caused by our relatively limited population and economic size, has been a central concept in CIAR's creation and growth.

Subsequently, in the early 1980's, Ontario created a science and technology council advisory to the Provincial Government. Based on advice from that council, the government established a program for a number of centres of excellence, and the experience gained with CIAR was drawn on heavily. These centres were required to focus on multidisciplinary issues in partnerships with industry and government; they were also required to have a formal structure and a Board of Directors as well as other means of accountability. These Ontario centres of excellence have not been included in this present study since they have very recently undergone a massive re-structuring with the seven remaining centres being re-organized into four completely new centres. These new structures have not yet fully stabilized and it is too early to examine the success or otherwise of them. Again, however, it is clear that a great deal of the conceptual thinking that lay behind the creation of CIAR was carried over into this provincial program.

Later in the 1980's, the Mulroney government established the National Advisory Board for Science and Technology. This Board developed a convincing and thorough proposal for the creation of the NCEs, and this was effectively

supported by the then Minister of Science, the Hon. W.C.Winegard who, very importantly, insisted that the NCE Program must be based exclusively on merit and must be totally free of political interference. In the course of this present study, the framework of the NCE Program has been described by a former senior civil servant as "the perfect political instrument", since the concept of the NCE is (i) national in scope so that regional politics are not involved, (ii) focused on economic development in Canada, and (iii) non-political in that all decisions regarding the choice of NCEs, their renewal etc are made by bodies that are at arms length from government and totally independent, and (iv) such decisions are based on peer review and assessment of intellectual quality.

The very important point to be made from the above history is that Canada's development of formal knowledge networks such as the NCEs is a result of some 15 years of experience. The concepts and principles come from solid intellectual grounds, and have been refined and modified through experience. This fact, taken in combination with Canada's economic development history, with the Canadian concern for quality of life and environmental issues, and with Canada's proud history of participation in international development, provides a convincing argument that we are uniquely prepared to take the next large step, with our county partners, into a knowledge-based future.

While the NCEs reflect the description of a formal knowledge network, others are also quite close. A network such as the Canadian Global Change Program (CGCP) or the networks of the Canadian Policy Research Network (CPRN) are highly focused and formally constituted. In each case, there is a well-defined management structure, and both accountability and discipline are expected of the researchers. These networks are not open to anyone wishing to participate. Selection of researchers is made on the basis of peer evaluation of either the individual's previous research, or of submitted research proposals appropriate to the network's declared theme. Both CGCP and CPRN have formal Boards and each produces an Annual Report.

The major difference in comparison with the NCEs lies in the fact that the outcomes from CGCP and CPRN are policy options and not marketable products. There is a major inherent difficulty with such policy oriented networks, namely that while the development of policy options is both necessary and desirable for any society, it is all too often not possible to determine whether such options had any real influence on policy-makers. No measurement of cost-benefit is possible, and ultimately, the credibility and reputation, which it establishes for itself over a long period of time, determine the value of such a network.

The Canadian Network of Toxicology Centres is one of the few existing Canadian networks that is focused on environmental issues. It also closely resembles an NCE, although it was built upon three existing but separate Toxicology Centres. In terms of its management by a Board, its incorporation

as a not-for-profit foundation, its internal structure, and careful selection of research projects within pre-determined themes, it is very similar to an NCE. Its environmental focus is significant and many of the issues with which it is concerned, (e.g., the development and validation of methodologies for the assessment of potential ecological and human health risks associated with exposure to chemicals) are applicable internationally and are central to sustainable development. Strong links should be forged as quickly as possible between this network and CIDA, IDRC and IISD.

Another network that is fairly close to an NCE is CANARIE, although its focus is much more market-oriented and it is not really in the business of generating new fundamental knowledge. It certainly generates new technological knowledge, as well as market products, and it has considerable importance in helping to maintain Canada's expertise and leading position in telecommunications and networking. While it may strain the imagination of the reader to try to conceptualize "networks of networks", nevertheless all existing formal knowledge networks should ensure the effectiveness of their own continuing links with CANARIE. All development agencies, and particularly CIDA, IISD and IDRC need some link with CANARIE, if only to maintain an awareness of current activities. In other respects, such as management, selectivity of projects, production of annual reports, etc., CANARIE is quite similar to an NCE.

CIDA Centres of Excellence show few similarities to NCEs. For this study, four of the Centres were interviewed. Although the CIDA Program which has supported the Centres has now concluded, two of the four will be continuing with essentially the same activities, with funding from CIDA's new University Partnerships and Collaboration in Development Program, informally known as UPCD Tier I. Each CIDA Centre is focused on a particular theme in which the university has already an established reputation, (e.g., in Human Settlements at the University of British Columbia). Scholarly activity within each Centre, supplemented by collaboration with partners in developing countries, enhances that reputation through publications, conferences, and monographs. CIDA required that each Centre create a network with its partners; again in the case of UBC, this involved three institutions in China, one in Indonesia, and one in Viet Nam. As in many other cases where links are established with institutions in developing countries, the telecommunications linkages are often limited so that communication is restricted to the use of mail, telephone, or fax.

It is somewhat surprising that while CIDA wished to see networks created, there was apparently no pressure for them to be formalized in any way, and nor have CIDA and/or the Centres applied any of the funding to enhance networking activities. As already indicated, none of these CIDA networks has a formal structure, nor do they seem to be directly managed. They clearly have been valuable in communication, in the enhancement of joint scholarly work, and in the administrative operations of the Centres (e.g., in making arrangements for

exchanges of faculty members and in forward planning for graduate students), and it is likely that some of these links will continue well after any CIDA funding has ended. But they are essentially informal networks, which will survive only as long as the interests of the participants are compatible. This is very different from the careful creation of an NCE network with its formal structure and management, which is then applied deliberately to the creation and application of new knowledge, and which may well become permanent and self-supporting.

This is not to imply that the CIDA Centres have not been well managed; indeed, it appears that in most cases the University concerned exercised appropriate oversight. At UBC, for example, the Dean of Graduate Studies chaired a CIDA Project Management Committee. Rather, CIDA does not appear to have defined sufficiently clearly the objectives of the program, and also did not specify anticipated outcomes of the program. There is little evidence that evaluation of the Program or the individual Centres was anywhere near as rigorous as those of the NCEs. While such statements may seem too harshly critical, they are supported by the fact that the interviewer was told in several instances that much of the research done by the Centres would have been done in any event. In most cases, then, the CIDA Centres have involved a continuation of existing scholarly interests, which will maintain their continuity either with UPCD Tier I funding or in the absence of CIDA funding.

In one area, the CIDA funding has made possible new activities that contribute substantially to human development. All of the Centres have been involved in graduate student education and training, with significant numbers of students coming from their developing country partners. In an academic sense, all of the Centres are multi-disciplinary in nature, and have been able to provide very appropriate environments for graduate students. Opportunities have also been made possible by networks, or more accurately through partners, for Canadian students to study in a partner institution. These are valuable contributions to sustainable development.

However, set against the characteristics of a formal knowledge network, as suggested earlier, the CIDA Centres fall short on many counts. While they certainly create new knowledge and disseminate it freely through scholarly publications and monographs, there is no aspect of the Centres that attempts to maximize the rate at which new knowledge is discovered; the Centres have a minimal level of structure and management, and since outcomes, or even expectations, have not been defined, there is little accountability. While written constitutions may exist in some Centres, there seems to be no evidence to suggest that they are as specific as in the NCEs. While some level of peer evaluation was applied in the initial selection of the CIDA Centres, the criteria that were employed and also the standards, seem to fall short of those used for the NCEs; for the latter, internationally recognized experts were engaged for peer

evaluation. Also, once the CIDA Centres were funded, there does not appear to have been any process in place to select participants on the basis of merit. Further, while the CIDA Centres have employed networking for ease of communication, none has had a well thought through communications strategy. Various pamphlets and brochures have been prepared and distributed, but these reflect only the continuing common practice of most university departments, centres, and institutes. And finally, there is only slight evidence that the Centres have worked actively to apply new knowledge and to reduce barriers between university researchers, government, NGOs, and the private sector. Very importantly, the CIDA Centres show no sign of change from the traditional scholarly activities of universities; there has been no "culture shift", and no degree of adaptation has been required of the participants.

Next, comment is warranted on the extensive experience of IDRC with networks and networking, as it compares with the characteristics suggested here for a formal knowledge network. Again, some details of the IDRC experience are described in the Appendix. It is very evident that IDRC has made, and continues to make, through its participation in networks, a very substantial and cost-effective contribution to sustainable development. But in relation to this present study, some important provisos need to be emphasized. It needs to be re-stated here that this is not a comprehensive study; a considerably longer period of time would be required to examine all, or even a major part, of IDRC's networking activities. But in any event, this would not have been appropriate since the purpose of this study was to examine existing Canadian knowledge networks, and not international development networks. On the other hand, it did seem essential to examine the mode of operation of some IDRC networks, and to determine the extent to which they are linked to, or draw upon, the intellectual resources of existing Canadian knowledge networks.

It should be mentioned here that there appear to be limited linkages in IDRC with what is happening intellectually in Canada at present. While IDRC rightly claims to have 20-25 years experience with networks, many of the IDRC staff who were interviewed for this study seemed to be less aware of the creation and significant accomplishments of the NCEs, or of the CIAR or CPRN networks, even where these latter exist in exactly the same fields as IDRC networks. This is consistent with the view, held by many in Canadian universities, that IDRC has allowed itself to become too isolated from the Canadian academic community.

In comparing IDRC networks with the ideal formal knowledge network, it needs to be recognized that IDRC networks have achieved considerable success in the generation and dissemination of new knowledge. These networks have also been very cost-effective, at least by comparison with methods used previously. However, there is little documentary evidence that IDRC networks maximize the rate of discovery of new knowledge or of its application. While IDRC

networks are managed usually through a full-time co-ordinator, there again seems to be little evidence that discipline is exercized either on, or by the network. As far as could be ascertained, the Boards of the various networks tend to have more of an advisory role, rather than one of management which demands full accountability, including the setting and meeting of firm timelines, and removal from the network of any whose performance is judged by peers to be inadequate. Also, it is quite clear that IDRC networks do not have, or rather have never developed comprehensive communications strategies aimed at Canadians. The existence of these networks is certainly known in the participating countries, but very little indeed is known of them in Canada, particularly in the academic community.

Lastly, too few IDRC networks create better links between the research community and the business sector in developing countries, even though this is critically important for sustainable development. In large part, this may be due to the limitations of IDRC's mandate, whereby it is empowered to undertake research in development with third world partners, but not to be involved in the full commercialization process. Yet our experience in Canada over the past 50 years has shown unambiguously that the production of new knowledge is not in itself that difficult; it is the complex process of converting new knowledge into economic and social development that is still poorly understood, difficult and often unsuccessful. To summarize then, IDRC networks continue to be useful and productive, but could learn much from the fact that Canada now has better models and deeper experiences of networks to bring to sustainable development.

ORBICOM is a different type of network. While its secretariat is located in Canada, ORBICOM is essentially international. UNESCO is the official sponsor for all of the Chairs in Communications, but each is funded quite separately. It is not then a managed network, but rather a collaborative one. Certainly ORBICOM generates and disseminates new knowledge, and engages actively in human resource development activities; it is also both multi-disciplinary and multi-lingual. However, it has no long-term strategic plan and no communications strategy. While the activities of ORBICOM are well described, the anticipated outcomes are not, other than the belief that communications provide an essential means of spreading skills and knowledge. A network such as ORBICOM cannot easily be reconciled with the description of the ideal formal knowledge network, since it has been established as an apolitical, neutral organization open to all streams of thought and opinion. This requires its management to be loose, its membership to be totally open, and its future direction to be determined from time to time by the members.

Finally, some consideration has been given to networks operated by non-governmental organizations (NGOs). A vast number of these exist, mostly as informal networks; those examined here are few in number and were selected to pro-

vide some indication of the way in which some NGOs use networks. Information was obtained from Friends of the Earth, Greenpeace Canada, Mines Action Canada, and the International Red Cross Federation. There has been no attempt to be comprehensive; many other interesting, Canadian-based NGO networks exist but were not interviewed. These include the Human Rights Network of the International Centre for Human Rights and Democratic Development, the NSI-based GERA (Gender and Economic Reform in Africa) network, the IISD-based Spinning the Web network, the Canadian Coalition for the Rights of Children, and the Canadian Centre for Policy Alternatives.

The IFRC (International Federation of Red Cross/Red Crescent) has been included because it demonstrates well, perhaps even to an extreme, the difficulties of building a knowledge network that includes both developed and developing countries and the NGO sector. IFRC is currently creating a global network, based largely on e-mail but also using other technologies, to enhance its capabilities in disaster relief work. It will become a knowledge network since it will define and collect information that is needed in disaster relief, and may substantially alter thinking as to how disaster relief should be provided. The description of IFRC in the Appendix illustrates the complexity and difficulty in creating, in the volunteer sector, an extremely large and geographically dispersed knowledge network.

Greenpeace Canada is quite different, although much of its activities are directed by its umbrella organization, Greenpeace International. It has a well-defined structure with a Board and an Executive Director who is accountable to the Board. While Greenpeace Canada is financially supported by its members who number over 100,000, the work of Greenpeace is conducted essentially by its staff who engage in literature research and the development of policy options. To assist in this, Greenpeace may contract research to an outside investigator. All major policy issues are discussed and determined by the Board. Of particular note is the sophisticated and comprehensive communications strategy that Greenpeace follows; over the last several decades it has been perhaps the most successful NGO, both raising public awareness, and in its lobbying activities. Greenpeace has generated new environmental knowledge in various fields, perhaps most notably on research relating to Antarctica, and this work with all Greenpeace research is published and widely disseminated. It is also interesting to note that while Greenpeace will not accept financial support from industry, it is nevertheless willing to work with corporations in seeking economically feasible solutions to environmental problems. In almost all respects, therefore, Greenpeace Canada matches the description of a formal knowledge network.

Friends of the Earth (FoE) is unique in its development of international policy. With 60 independent international organizations, each FoE office selects which international issues will become a campaign for their office. For issues of international significance, FoE groups use their annual general meeting to con-

sider and agree on mutual priorities, thereby establishing the international campaign. This clearly identifies that FoE develops policy using a "bottom-up" approach. Friends of the Earth seems to be less involved in the generation of new knowledge than does Greenpeace Canada, although both have a similarity to the Canadian Policy Research Network, in that the ultimate outcome in each case is policy generation.

Mines Action Canada (MAC) does not really qualify as a knowledge network; its roles are almost exclusively advocacy and raising public awareness. Given that an international treaty banning the use of landmines was signed in Ottawa in December 1997, the efforts of MAC and its related partners have obviously been very successful. It is reasonable to make some comparison of Greenpeace Canada and MAC, since both have advocacy as a major role. They also are exact opposites. While in Greenpeace the permanent staff does most of the lobbying and essentially all of the research, in MAC it is the grass-roots membership of many organizations and institutions such as churches, which publicize and advocate at the local level. Moreover, MAC has deliberately kept the issue as simple as possible—either one agrees that landmines should be banned, or one does not. Greenpeace however is involved in complex environmental issues for which the best solution is by no means obvious, and there can be a number of options from which to choose. Finally, it is worth emphasizing that these NGOs are, by definition, based on democratic principles; any Canadian can join, although with Greenpeace one can only join by making a financial contribution and even that does not give voting privileges. But there is absolutely no element of selection leading to a determination as to who is in the network and who is out.

CONCLUSION

Before turning to recommendations that arise from this study, there are three final comments to be made. First, the Strong Report recommends that, as Canada builds new knowledge networks, it will also need quite urgently to strengthen the institutions on which such networks are based, such as universities and research institutes. Underlying that recommendation seems to be a feeling that over the last two decades, universities in particular have been weakened financially and academically; this raises the question of how formal knowledge networks such as the NCEs will, over the long term, affect them.

In the course of this study, this question was put to many, and the overall answer seems to be as follows. Some responded by pointing out that the NCE Program is strengthening the universities since it is bringing additional research funding, and is certainly in many cases providing new research equipment that would otherwise not be available. These observations are correct, but they relate more to the role of the university as a funding source for research, and as an owner and provider of property and equipment. However, the true nature of the university lies within its character as an intellectual community, and the fact of the matter is that the university over the last five decades has become less and less a community. Faculty members and researchers feel far more involved and committed to their discipline and even a sub-discipline than to the university as an institution. The university becomes more and more the landlord who provides buildings and other facilities such as computers, scientific equipment, and a library, as well as accounting services for research funds; but it is not the intellectual community to which the faculty members give first allegiance.

The creation of formal knowledge networks such as the NCEs as formal institutions is reinforcing that trend and will continue to do so as the number of these networks increases. Such networks weaken still further any remaining sense of the university as an intellectual community. From some interviewed, the response was "So what?" others, however, considered that the undergraduate teaching function would still keep the university together. When one takes into account not only this issue of community and commitment, but also the observations that networks such as the NCEs are dealing far more effectively than universities with issues such as multi-disciplinarity and graduate education, it seems more than likely that the growth of formal knowledge networks may well be one of the levers that ultimately brings about needed fundamental change in the universities.

The second comment relates to the fact that, underlying all of this discussion, is a serious contradiction. In most discussions about sustainable development, there is the assumption that national economies are largely independent and can

be controlled by national governments. Yet it is widely known, and increasingly so, that this is not true, and that multi-national corporations increasingly exercise influence over a global economy, and increasingly make any concept of a national economy irrelevant. The continuing discussions on a new Multilateral Agreement on Investment clearly reflect this. If we are indeed some distance down the road to a global economy, how then can we continue to focus on Canadian development? Is global sustainable development now the only issue on which we should focus? Should a program such as the NCE Program be evaluated in terms of what it contributes to just the Canadian economy, or by its contribution to global sustainable development?

The final comment concerns the fundamentally important issue of public good versus proprietary knowledge. All of the Canadian networks described here believe strongly in the principle that new knowledge must be widely and freely disseminated. The NCEs and perhaps other networks, however, grant the rights of development and application of that knowledge exclusively to particular industrial affiliates. The goal of these affiliates is profit generation; profit for the corporation and further financing for the research network. But new jobs are created, new wealth generated and further social development supported. In other words, this is how sustainable development occurs. This requires, however, a very fine balance; as economic development occurs, all too easily social disparities can be increased rather than decreased, and the gaps that presently exist between developed and developing countries can be widened still further. Yet this use of new knowledge, in today's global economy, is essential for further sustainable development; the tension between public good and the proprietary use of new knowledge will remain and must be managed by both governments and society.

On the other side are issues central to the success or failure of policy oriented networks, which experience much greater difficulty in obtaining stable funding even though their research is often of vital importance to both Canada and developing countries. There is a clear need for there to be multi-stakeholders in such policy networks, but unless business can see some benefit from involvement, it is unlikely to become involved. A negative approach can sometimes be useful; in the Sustainable Forest Management NCE, forest companies participate because they consider that their continuing certification requires it. If it is claimed by some in the business community that the scientific evidence for global warming is still ambiguous, then should not business directly support and participate in the research of networks such as the Canadian Global Change Program until such ambiguity can be removed? Considerable thought is required to find new and appropriate ways for the private sector to be fully involved in all formal knowledge networks, and not just those that lead to immediate market products and short-term profit.

In conclusion then, Canada is clearly in an advantageous position in its development and application of formal knowledge networks. Some existing networks are already beginning to contribute directly to sustainable development in Canada, and have the potential to do so internationally; many others will do so substantially in the next few years. Many other new networks should be created as a matter of considerable urgency if Canada is to benefit from the competitive lead we now have. A fundamental objective for them all should be to contribute in specific defined ways, to global sustainable development, not just development in Canada. Our full commitment to the sustainable development of both Canada and our country partners will be required, since that will ultimately sustain us all.

SUGGESTED ACTIONS

I.   *Canada should officially accept the recommendation of the Strong Task Force that knowledge, and the communications and information technologies that can advance knowledge, be placed front and centre in Canadian foreign policy and Canada's international outreach.*

      Comment: The Strong Report itself provides convincing arguments for this action. Now, the present study demonstrates the leadership position that Canada has established in the creation and use of formal knowledge networks, and how such networks can contribute to sustainable development. This study also indicates that such action is required to maintain and enhance Canada's capacity as a leader in sustainable development and knowledge networking.

II.   *Canada should act with regard to the above recommendation with considerable urgency.*

      Comment: As the Strong Report points out, "the kinds of knowledge networks that are required will not emerge through some amorphous process of technological determinism"; rather, thoughtful and innovative processes, such as that which has led Canada to the NCEs over the past 15 years, must be nurtured and encouraged as a matter of official Canadian policy. If Canada has a lead over other countries in the development of formal knowledge networks such as the NCEs, it cannot be a lead of more than 10 years, and Canadian policy should build on this with urgency and determination.

III. *IDRC and IISD should urgently undertake jointly the development of mechanisms, which will keep them informed about existing formal knowledge networks in Canada, and in appropriate cases should undertake the creation of formal partnerships.*

      Comment: Greater knowledge of and familiarity with formal knowledge networks in Canada will only enhance the effectiveness of organizations like IDRC, IISD and CIDA. Some effort will be required to identify all relevant networks; the list should include the NCEs and most of the other networks listed in this report, but should not be restricted to these; there are certainly others that are relevant to sustainable development. But the value of continuing strong ties with the Sustainable Forest Management NCE, TeleLearning, the Canadian Network of Toxicology Centres, many of the networks of CIAR as well as those of CPRN, among others, is obvious in terms of their relevance to sustainable development.

IV.   *Where appropriate, Canadian development agencies should engage Canadian formal knowledge networks in partnerships, in contracts, and other forms of development activities.*

Comment: This suggestion has clear advantages particularly for the development agencies. For example, a CIDA contract with any of the NCEs ensures that the very best Canadian expertise is offered to a partner country. This is an enormous step forward from the present situation where CIDA, for example, contracts with one university or one company neither of which has all of the Canadian expertise. Moreover, both as organizations and as legal entities, as well as with their more direct and firm management, NCEs are probably better placed to meet expeditiously all contractual obligations on international development projects than are universities.

V.   *IDRC, IISD and CIDA should, on an urgent basis, convene a working meeting to consider:*

(a)   *which Canadian knowledge networks contribute to global sustainable development, and in which fields;*

(b)   *what new formal knowledge networks might be created that relate to other aspects of sustainable development, and what their purpose, structure and management might be; and*

(c)   *what mechanisms can be used to fully integrate existing Canadian networks with international sustainable development activities?*

Comment: Given the entire thrust of the Strong Report and of this study, the need for the three organizations and others to become directly involved themselves in formal knowledge networks, both within Canada and abroad, should be apparent. As a first step, this might well involve partnerships with existing networks such as some of the NCEs, linking them into international projects, as suggested above. It may, however, transpire that the best way to do so will be through the creation of some completely new structure. Such involvement of the NCEs would also, of course, bring their industrial affiliates into international development activities. In fact, any such involvement of an NCE would only occur if all network participants were in agreement. But this involvement would have the prospect of bringing new sources of funding to sustainable development activities. Certainly it would raise a number of fundamental issues, such as the balance of social benefit against commercial financial gain, but many of these are probably overdue for discussion, especially within the context of our growing understanding of sustainable development.

It will be essential, therefore, to prepare carefully for such discussions, and to draw on the best Canadian wisdom and expertise in considering how best to undertake these initiatives. As a first step, a meeting should be convened of a small number of key representatives of IISD, IDRC, and CIDA with not more than 5 external persons knowledgeable and involved with existing formal knowledge networks. Without excluding the consideration of others, but rather to stress the level of seniority and experience that should be involved in such a meeting, persons such as Dr. John Evans, Dr. Judith Maxwell, and Dr. Fraser Mustard come to mind.

Also, of course, it is clear that Canada cannot be the intellectual leader in all fields of knowledge, and that both in terms of Canadian sustainable development as well as the development of partner countries, hard priority choices will have to be made. Such choices will necessarily reflect what the Canadian people believe to be the important and essential components of a sustainable global society. In the course of this study, different views have been expressed, but all have agreed that Canada's emphasis should be, in terms of foreign policy and sustainable development, on fields such as health, the environment, education and human development.

For the meeting described above, sufficient preliminary work should be done so that participants have had an opportunity to contribute to agenda development, and that the detailed agenda has been circulated sufficiently in advance so that participants have had time to think through the various issues prior to the meeting.

APPENDIX

There now follows a brief description of each of the networks, together with a summary of comments covered in the various interviews. In combination, these provide substantial and strong evidence for the observations and conclusions given in the text of this Report.

When this report was being written, it was publicly announced that of the 10 NCEs that were due for review and possible renewal in 1997, seven will be renewed and three will not be renewed. The program is clearly exercising a high degree of selectivity. Because there is something to be learned from each and every formal knowledge network, all those interviewed have been described here without differentiating between those renewed and those not renewed.

The networks are described in the following order:

Canadian Bacterial Diseases Network (NCE)

Canadian Genetic Diseases Network (NCE)

Canadian Global Change Program

Canadian Institute for Telecommunications Research (NCE)

Canadian Network of Toxicology Centres

Canadian Policy Research Networks

- Family network

- Work network

- Health network

Canadian Institute for Advanced Research (eight networks)

CANARIE – Canadian Network for the Advancement of Research, Industry and Education

CIDA Centre for Human Settlements

CIDA Centre – Canada-Asia Partnership Program

CIDA Centre – PARADI

CIDA Centre – Urbanization and Development

HEALNet – Health Evidence Application and Linkage Network (NCE)

INSPIRAPLEX (NCE)

Institute for Robotics and Intelligent Systems (NCE)

International Development Research Centre

Mechanical Wood-Pulps Network (NCE)

MICRONET – Microelectronic Devices, Circuits, and Systems (NCE)

NGO – Friends of the Earth

NGO – Greenpeace Canada

NGO – Mines Action Canada

NGO – International Federation of Red Cross/Red Crescent Societies

Neuroscience (NCE)

ORBICOM

PENCE – Protein Engineering (NCE)

Sustainable Forest Management (NCE)

TeleLearning (NCE)

CANADIAN BACTERIAL DISEASES NETWORK (CBDN)
University of Calgary

This Network is now seven years old and well established. Canadian Bacterial Diseases Network (CBDN) consists of 53 members located in 14 universities and four government departments. The members are carefully selected by criteria based on merit. Not all applications or nominations are accepted since not all meet the criteria of scientific excellence. In a few other cases, former members of the Network have not met expectations and have been asked to relinquish membership.

CBDN has established a cohesive and focused group of scientists directed towards the development of three product/major theme groups: Vaccines, Diagnostics, And Therapeutics. Eleven project focus groups span all three major themes from Antibiotics and Antibiotic Resistance to Animal and Aquatic Health to Diagnostics and *Streptococci*.

A Board of Directors consisting of 14 persons manages CBDN; five are from the business sector and five are from universities. The Board has the usual responsibilities of a corporate board, although CBDN is not itself incorporated. From interview comments, it would appear that the Board in this case acts in a more reactive than proactive manner. The Scientific Director is not CEO but reports to the Board. A Scientific Advisory Board of external experts provides advice to the Scientific Director on the overall scientific direction of CBDN. The CBDN Network Science and Budget Committee reviews and gives funding approval for all scientific projects within the broad theme areas of CBDN. The Network has a Managing Director and CEO, a Marketing Manager, and a Manager for Finances and Communications.

In addition to the 53 members, nine government agencies, six foundations, and over 50 industrial affiliates are associated with CBDN. The financing of CBDN over the last three years has consisted chiefly of $19.2 million from 50 industrial partners and $12.2 million from the NCE Program. CBDN has already produced nine spin-off companies, which are in varying stages of the entrepreneurial cycle; these have created 81 jobs for Canadians. To date, there have been more than 100 technology disclosures, 58 patent filings, and 45 collaborative research agreements from CBDN.

INTERVIEW COMMENTS:

The following are the major points covered in an interview with Dr. D. Woods, Scientific Director, and Ms. K. Corraini, Managing Director and CEO.

1. The creation of CBDN and the nature of its structure and operations have brought about a major culture change among CBDN scientists, who now appreciate the benefits of networking and collaboration. There has, for example, been an almost five-fold increase in the number of multi-research group scientific publications. Also, the members now appreciate the views and needs of industry so that their research programs have been re-oriented. This was confirmed in discussions with several CBDN scientists who admitted openly that, when they first joined CBDN, they looked on it as just another source of funding but that the reality has been quite different. The networking and collaboration with colleagues and with industry has led to completely different and unexpected directions for their research.

2. CBDN believes that it can become self-supporting over the next seven years, although it may have to become much more highly focused.

3. NCEs provide an excellent multi-disciplinary environment for the training and education of graduate students who also obtain a familiarity with industry. In the last year, 90 students were receiving their graduate education in CBDN laboratories; 45 students graduated from the CBDN training program and all 45 were able to find employment in their chosen fields prior to graduation.

4. While communications is described as a major responsibility of the Manager for Finance and Communications, there is no evidence in the material available that CBDN has a well-developed communications strategy.

5. Commercialization of CBDN research is a central objective, and also CBDN, and the other NCEs, are expected to benefit the Canadian economy. CBDN recognizes that in a global economy, and especially in fields relating to bacterial diseases, commercialization may well take place globally, and that the benefit to Canada may well be in the form of license fees or royalties. There seems to be no sign of a full policy statement describing the way in which CBDN intends to interpret "economic benefit to Canada".

6. While CBDN itself is not incorporated, it has established the Canadian Microbiological Consortium Inc. as a not-for-profit corporation. The mission of CMCI is to become an internationally-recognized competitive specialized technology management company. CMCI has the same Board of Directors as CBDN.

7. CBDN is involved in networking with other NCEs, particularly PENCE and CGDN. Bacterial diseases are, of course, particularly prevalent in developing countries so that the work of CBDN could have considerable significance in international development. Interestingly, CIDA is a partner in CBDN and is supporting research on bacterial diseases in Ethiopia.

THE CANADIAN GENETIC DISEASES NETWORK

This Network is one of 14 presently existing NCEs. Its administrative centre is at the University of British Columbia, and it involves researchers at 16 universities and hospitals, together with 12 industry partners and affiliates. The total funding for the Network in the 1994-1995 year was approximately $12.3 million; this includes all research support from both MRC and industry, a significant portion of which would still have been received had the Network not existed. In that year, $5.9 million came from the federally-funded NCE Program. Industry support has risen from $0.1 million in 1990-1991, to $1.3 million in 1994-1995.

A Board of Directors governs the Network with 13 members of whom eight come from industry, and the rest from universities. The Board functions very much as a true corporate board, and the Scientific Director (or CEO) is in a definite reporting relationship to the Board. He is also the Chair of the Planning and Priorities Committee to which all investigators and facility directors report. The Network is founded on research excellence and at the time of its founding a careful screening process based on strict criteria was employed to identify those researchers who would be invited to participate in the Network. In addition to the Scientific Director and all of the investigators, the Network also employs (on a full-time basis) a Managing Director who oversees the operations of the Network (but not the actual scientific research), a Network Manager who deals with all networking and communications issues, as well as annual meetings and more frequent group meetings, and a Commercial Director who is responsible for all aspects of commercialization.

The research programs of CGDN have already: led to the discovery of two genes that cause familial Alzheimer's disease; identified new genes involved in apoptosis; participation in the identification of genes in breast and ovarian cancer; identified the gene for Wilson disease; participated in the discovery of the gene loci for juvenile onset diabetes; developed an animal model with gene targeted disruption for Huntington disease; developed new technology for protein sequencing and for DNA sequencing; and established databases on mutations in populations used as models world-wide. An external Scientific Review Panel examines all research proposals before they are undertaken, and where appropriate an external Ethics Panel may also review proposed research.

A very important component of CGDN's work has been to develop and strengthen core technology facilities located at centres across Canada; these provide state-of-the-art support for Network research in a manner that separate universities could not have provided. Core facilities are provided for such

technologies as DNA sequencing, gene targeting, protein analysis, somatic cell mapping, and others.

One of the basic objectives of the federal NCE Program is to link university researchers and industry, and to thus directly benefit the Canadian economy. The relationships with industry have now developed to the point that there is a well-conceived approach to the commercialization of biomedical discoveries, and by 1995 at least three spin-off companies had been established with others following rapidly. The Network has set up a Strategic Fund intended to accelerate research projects with strong commercial potential and is presently funding three such projects. The Network also has the framework for a business plan that they are confident can make the Network self-supporting within the next seven years.

Interview Comments:

The following are some of the major points covered in an interview with Dr. Michael Hayden, Scientific Director, and Mr. Stephen Herst, Managing Director.

1. The fundamental principle on which the Network is founded and sustained is research excellence as determined by peer review. A second principle relates to the ability and willingness of the individual researcher to be a "team player".

2. The Network has achieved a remarkably high level of collegiality and willingness to work cooperatively. This is viewed as a unique Canadian accomplishment.

3. The Network has brought about a convergence of views, between academic researchers and industry, on the commercialization of biomedical discoveries and there is now a common sense of purpose.

4. At UBC, as well as some other (but not all) universities, the University holds the first claim on ownership of intellectual property. This is causing some serious tensions, although it has still been possible, with this added difficulty, to move towards full commercialization.

5. The Network achieves a level of multi-disciplinarity that has not been possible within universities. This characteristic also ensures an excellent broad environment for the education and training of graduate students; to date, these have all been Canadian students.

6. The Network considers communications and public relations to be important responsibilities; lectures and seminars have been given in schools and community groups, articles have appeared in several news-

papers, and CGDN has been featured on both TV and radio. It is not clear whether CGDN has a well-developed communications strategy or whether the above activities have been reactive responses to inquiries.

7. As of the present date, CGDN believes that it has been responsible for the creation of six spin-off companies, and of approximately 1500 jobs.

8. The work of CGDN has obviously global application, even though the economic benefits are presently directed within Canada. There is considerable potential for CGDN to work internationally, and there is already some involvement in Africa. The objective of this work stems from the fact that although many of the world's infectious diseases were once thought to be eradicated or controlled, they are now returning with unprecedented force, especially in third world countries. While there are complex reasons for this, there is emerging evidence that susceptibility to diseases such as malaria, TB, leprosy, HIV, etc. is genetically based. The CGDN makes it possible, for the first time, to bring the best Canada-wide resources together to address such issues in Africa, and more specifically in Ethiopia.

CANADIAN GLOBAL CHANGE PROGRAM
Royal Society of Canada

Founded in 1985, under the auspices of the Royal Society of Canada, the Canadian Global Change Program brings together scientists and other specialists from many disciplines in the sciences and humanities to plan interdisciplinary research, assess the significance of this research in the policy context and communicate the implications to its target audiences. While the Council of the Royal Society of Canada has overall responsibility for the Program, the CGCP has its own Board of Directors of 15 persons plus four ex-officio representatives of the Royal society. Four come from the private sector, five from government departments or agencies, and six from universities.

Funding for CGCP comes largely from the Federal Government under the Green Plan, with smaller contributions from the Richard Ivey Foundation and targeted funding for specific projects. The total budget in 1995-1996 was approximately $1 million. The three main themes of CGCP's work are:

- research assessment and policy options
- research planning and collaboration
- information management and communications

CGCP thus assesses research results relevant to climate change, using expert panels, research/policy forums and commissioned studies, in order to promote a wider dialogue on the various policy options or significant issues affecting Canadian society. CGCP also emphasizes research planning and collaboration; it ensures Canadian participation in international climate change research programs and has published *"Understanding Our Changing Planet: An Overview of Global Change Research in Canada"* which gives a comprehensive overview of Canadian research. CGCP places emphasis on information management and communications; it publishes special bulletins for decision-makers, it has a website on the Internet, and is very active in environmental education through workshops for teachers and preparation of teachers' guides.

Under the above three themes, CGCP invites research proposals from researchers; these are examined critically by the Research Policy Committee with only some being approved; this Committee also monitors ongoing research projects. The fundamental goal of CGCP is to create new knowledge in policy areas, but not to carry out itself or to sponsor scientific research. The Program is not involved in graduate education and training.

Interview Comments:

The comments below were provided during an interview with Dr. Jeffrey Watson, Scientific Director:

1. Since many of CGCP's activities are voluntary, there is a question as to what holds the Program together. The answer seems to be that it is very much a matter of intellectual interest in climate change issues, coupled with the fact that there is good peer evaluation and the quality of the work is high. The fact that CGCP has limited amounts of funding to disburse also helps give the network cohesion.

2. The Board is considered to function more as a corporate board, to take a real interest in the actual programs of CGCP, and to maintain strategic direction.

3. There are many climate change programs worldwide; each needs to find its own niche. Attempts to integrate the various programs worldwide have so far failed.

4. CGCP does have a well-developed communications strategy, although it is not followed precisely. There is awareness of the considerable need for public communication, and following every Board meeting (twice yearly); a media event is held to publicize both climate change issues and CGCP activities. CGCP also tries to target its various publications and media activities at particular audiences.

5. CGCP functions in a way that is very similar to that of CPRN. It holds many roundtables on specific theme issues in attempting to reach consensus between scientists and social scientists. However, the impact of CGCP on Environment Canada, in terms of its programs and policies, is not easy to ascertain.

6. CGCP has informal links with IDRC, is part of the informal network built around the Centres for Sustainable Development, and has informal links with other climate change programs worldwide.

7. While thought has been given to the development of formal links with some organizations, no decisions have been made.

8. Ownership of intellectual property is not a problem with CGCP, by nature of the central theme. Information about climate change should in any event be freely available.

CANADIAN INSTITUTE FOR TELECOMMUNICATIONS RESEARCH (CITR)

CITR is a non-profit research company devoted to enhancing the competitiveness of Canadian industry through university-based research and postgraduate studies. It is managed by a Board of Directors of whom more than half are from industry.

The Scientific Director acts as CEO and reports to the Board. Responsible to the Scientific Director are the Major Project Leaders who guide the research in six major themes. These are:

- Telecommunications technologies;
- ATM network resources management architecture;
- Broadband services;
- Broadband Wireless Communications/LMCS;
- Mobile and Personal Communications; and
- Broadband Satellite Communications.

Researchers work on these themes as either individuals or in teams. The selection of participants is done very carefully; since they must have strategic values and be willing to engage in multidisciplinary research that have been defined "top down". The objectives of CITR are first to conduct world-class research, second to benefit the Canadian economy, and third to build an efficient, multisectoral network.

The principal source of funding for CITR is the NCE Program, although it seemed that at present about 20% of the budget comes from industry sources. The view is held that it is unlikely that CITR can become financially independent of government and that continuing government funding will be required. CITR also hopes to increase substantially the number of industrial contracts for research on specific projects.

CITR is not a large NCE—it claims to be highly selective and involves researchers from 18 universities and two government research centres. Since its inception, there has been a 20-25% turn over of the initial researchers, some of whom have become less relevant to any of the major research themes.

CITR is heavily involved in training and graduate education. At any one time, there are about 60 post-doctoral fellows and 200 graduate students associated with CITR.

Interview Comments:

The following summarizes the major points covered in an interview with Dr. B. Prasada, Scientific Director of CITR.

1. CITR has been important in establishing a complementary relationship among the researchers, and in developing new types of interactions.

2. CITR provides, as a network, a very superior environment for graduate students. Its multidisciplinary character is a very important new asset.

3. There is a great deal of self-selection in terms of the participants in CITR and, as a network it is becoming more industry-oriented. CITR has chosen to work with a limited number of industrial affiliates and the relationship with them has grown closer with time.

4. As with some other NCEs, CITR considers that there are serious problems between the network and the universities on the issue of ownership of intellectual property. While this tends to be a difficulty associated with technology transfer offices within universities, there is some continuing tension between the demands of industrial research and the university goal of fundamental research.

5. CITR has a communications strategy consisting of:

    *   an annual conference, restricted to members

    *   separate meetings at least once per year for each of the major research themes

    *   a regular newsletter

    *   informal communication as required

6. CITR could be a stronger research network if there was international participation. However, the ownership of intellectual property would then become a much greater problem, and in addition, the NCE Program stresses that there should be economic benefit to Canada. Further still, industry wants only exclusive relationships. Despite these difficulties, CITR has already had some discussions with CIDA although nothing specific has yet emerged. CITR sees considerable opportunity internationally; especially in cases where CITR could become involved in a developing country where a CITR industrial affiliate wished to develop an initiative. Canadian industry could certainly fund CITR research on satellite communications in a developing country, although it would need to be done strategically.

CANADIAN NETWORK OF TOXICOLOGY CENTRES

This formally constituted network was established in 1992 and differs from many other Canadian networks in having three equal nodes, rather than a single head office. The three nodes consist of three toxicology research centres located at the University of Saskatchewan, the University of Guelph, and jointly at Université de Montréal and Université du Québec à Montréal. The Network is legally incorporated as a not-for-profit foundation with its head office located at the University of Guelph. An 11 member Board of whom five come from the academic community, two from government, and four from the private sector manages it. A much smaller Management Committee deals with routine management issues. Core funding for the Network comes from Environment Canada under the terms of the Green Plan; $14.1 million was committed for a five-year period. It is expected that other research grants and/or contracts will supplement the latter; in the 1995-96 financial year the total expenditures of the Network slightly exceeded $2 million.

The Board has the usual responsibilities of a corporate board of a not-for-profit corporation, financial and legal responsibilities, and responsibility for determining the strategic directions of the Network, but is not involved in the scientific programs. These are managed through an Expert Advisory Committee, the majority of whose members are presently from the United States. This Committee undertakes an annual review of the four major programs and the projects of which they are comprised. This Committee first approves new projects, which may be undertaken by any researcher in Canada, and excellence of research as determined by peer review is stressed throughout. Unsuitable proposals (i.e., that are not relevant to the major themes) are rejected, and unsatisfactory performance can, and has, led to a researcher being dropped from the Network. There is, in other words, firm direction and solid management given to the Network's operations, with full accountability being required by the Board and the Expert Advisory Committee.

The Network has five major program themes:

a) Metals Speciation Research Program, which has recently focussed its efforts on studies of the uptake of cadmium by aquatic and terrestrial species.

b) Immunotoxicology Research Program, which is concerned with the interaction of chemicals with the human immune system.

c) Reproductive Endocrine Research Program, which is presently seeking to develop methods to evaluate the effects of chemical exposure on reproductive/endocrine physiology of mammalian and fish species.

d) Quantitative Risk Assessment Program, whose objective is to develop and validate scientifically-sound methodologies for the assessment of potential ecological and human health risks associated with exposure to chemicals.

e) Public Education and Communications Program, this is a corporate responsibility and is clearly taken very seriously. For example, in collaboration with the Alberta Protection Agency, the Network has developed a toxicology education unit for secondary school science coordinators across Canada. In the first four months of its introduction, over 1500 requests have been received for the unit consisting of an educators guide and 12-minute video.

Interview Comments:

During the interview, with the Executive Director, Dr. L. Ritter, the following points were made:

1. The value of the Network lies to quite a degree in the multi-disciplinary value, which it adds. This is reflected both in the nature of the toxicological studies that are undertaken, but even more so in the superior multidisciplinary environment that is created for graduate students.

2. The Network enables a broad research program to be undertaken with cohesion and many added values.

3. The Network provides, in a unique way, the platform for constructive scientific interaction between industry as manufacturers and users, governments as regulators, and basic scientists.

4. The Public Education and Communications Program, undertaken as a corporate responsibility, is made possible by the existence of the Network; it would not have otherwise been an initiative of any single university.

5. The Network enjoys relatively good relations with the Universities where its nodes are located, and believes that it helps strengthen these institutions.

6. The Network has not encountered any difficulties with regard to ownership of intellectual property, and in fact has given little thought to the need for development of an appropriate policy.

7. The Network has no substantial international involvements at present; there is however an interest in developing such links. Certainly the science of this Network as well as its communications program could be utilized in international development, and at the very least IISD, CIDA, and IDRC should keep themselves regularly informed of CNTC's activities.

CANADIAN POLICY RESEARCH NETWORKS (CPRN)

CPRN is an independent, not-for-profit organization with charitable status. It has developed an open, inclusive approach to knowledge creation, and has created three networks connecting researchers, policymakers, private and non-private experts, and front-line workers. The management of CPRN is in the hands of a Board of Directors composed of 13 persons of whom five are from the private sector, four are from government, and the remaining four from CPRN itself. The Board meets twice a year. The President of CPRN acts as CEO and is responsible to the Board.

As a freestanding, autonomous body, CPRN is financially vulnerable, although it believes that the learning curve it has been through over the last several years is now bringing some stability. CPRN operates on an annual budget of approximately $2 million; in 1996, $400,000 came from the federal government, $750,000 from grants, and $320,000 from donations.

CPRN has developed three knowledge networks: the family, work, and health networks. Each network has its own director and also its own advisory committee, which shapes the overall agenda. Within each network, specific projects are identified and carefully chosen researchers are asked to undertake each one, often with the guidance of an advisory committee. In some instances, the project will be undertaken on a contractual basis, but regardless of the specific arrangements, the merit of the researcher, based on peer review, is the central criterion. Also, in all cases, the negotiations for participation in any of the networks are based on agreement on specific deliverables and on a firm time frame. Since CPRN is primarily concerned with policy issues, care is always taken to ensure there is a diversity of views on every project team. In general, the mode of operation of each network and project is through the usual forms of networking (telephone, fax, e-mail, etc.) together with annual meetings.

Interview Comments:

The following summarizes many of the points covered in an interview with Dr. Judith Maxwell, President of CPRN.

1. CPRN has already accomplished much, particularly in developing acceptance of CPRN as "neutral space" where conflicting views on policy issues can be discussed constructively.

2. CPRN is quite unusual (although similar to the Canadian Global Change Program) in being able to bring together scientists and social scientists for "shared learning".

3. CPRN as part of its Health Network conducts a research program in population health. There is now much involvement and mutual interest between those involved in this program and the researchers of the Population Health Program of the Canadian Institute for Advanced Research, thus again bringing into contact both the scientists and those working on policy issues.

4. CPRN is located in the same building in Ottawa as IDRC; even though their interests and objectives are very similar, there has been very little interaction and almost no joint work.

5. CPRN has had little involvement previously with graduate student education and training. However, this is now beginning to occur and is expected to increase: the benefits of the multi-disciplinary environment that CPRN can provide are being recognized.

6. CPRN is very interested in developing international involvements and has in the past given thought as to how this might be initiated. However, the funding base for CPRN is still thought to be somewhat insecure, and funding stability will be necessary before any international initiative is undertaken.

THE CANADIAN INSTITUTE
FOR ADVANCED RESEARCH (CIAR)

The Canadian Institute for Advanced Research, created in 1982, is a private sector initiative whose unique mission is to mobilize and focus the knowledge resources of a vast and thinly populated country into an international network of extremely talented individuals working in intellectually demanding fields. Its guiding principles are intellectual excitement, fundamental inquiry and quality of the highest international standards.

The Institute's eight programs are intended to emphasize the important role that science and technology play in sustaining and enhancing Canada's international competitiveness, and the urgent need to find new ways to create more civic and economically sustainable communities. The programs of CIAR build on Canada's research strengths and focus on excellence. CIAR considers that the strength of the Institute "lies in its success as a vehicle for partnership among universities, governments and the private sector, by locating outstanding talents whose combined spectrum of interest, knowledge and creativity holds promise of synergistic productivity".

CIAR's mission is itself conditioned by several guiding principles: each area considered for investigation should have the potential of major contribution to public interest and/or advancement of the natural and social sciences; promise the possibility of significant challenge to current intellectual paradigms; require synergistic collaboration among researchers from diverse disciplines; take advantage of the networking of researchers from different institutions and locations; and be a research area which would not be productively pursued in the absence of CIAR's initiative. Although the initial CIAR networks were exclusively Canadian, the present networks have a significant international component. The eight network programs now involve 93 researchers and scientists at 23 Canadian universities, and 63 international researchers and scientists working in 30 American institutions, 11 European institutions, two in Australia, one in Japan, and one in Israel.

CIAR is managed through an independent Board of Directors whose members have full corporate responsibility. The Board has been of central importance in forward planning for CIAR, and especially in maintaining its financial viability during some extremely difficult periods. The Board is evenly split between academic and private sector members. Currently, CIAR is operating on an annual budget of approximately $9 million but it has an accumulated deficit of $1.0 million and outstanding loans of $1.5 million. Its financial position has improved greatly over the past few years, but it certainly has not yet achieved financial stability.

CIAR funds only people; it does not fund equipment, or bricks and mortar. CIAR appoints Fellows and Scholars to its Programs and pays a portion of their salaries for a five-year term. This allows release time from teaching so that Fellows and Scholars can concentrate on research.

The present CIAR Programs fall into three major groupings:

1. Individual and society health and well-being:

    a) Population Health

    b) Economic Growth and Policy

    c) Human Development

2. Science relevant to the physical and biological origins and preservation of our planet:

    a) Cosmology and Gravity

    b) Evolutionary Biology

    c) Earth System Evolution

3. Science with Major Technological Potential:

    a) Soft Surfaces and Interfaces

    b) Superconductivity

While each of these Programs operates independently, the first three are cross-linked through the Human Science Cross-Program Linkages Group. This aims to bring scholars from each of these three programs, and additional CIAR Fellows and Scholars, together to fit these pieces into a coherent whole.

The project has three major goals:

1. To understand the adaptive mechanisms that promote social and individual well-being, examining a range of factors including population health, human development, social justice, and economic growth.

2. To understand how the effectiveness of societies in promoting social and individual well-being varies across different social contexts, including changes over time, during different circumstances of social change, and across different social units.

3. To develop empirical indicators of social and individual well-being that can be used to track progress, and guide policy-makers in creating the kind of society in which people can best live a worthwhile life.

Each of the CIAR Programs has a separate Advisory Committee, which is composed of outstanding international experts in the particular field. These Committees provide on-going advice to the Programs; each Program meets annually with its Advisory Committee to report and consult. On a five-year basis, each Program is critically reviewed by an independent review team which is asked not to indicate whether the Program is operating satisfactorily, but whether it is internationally outstanding and at the very forefront of its field.

Interview Comments:

In interviews with Professor J.S. Dupre, President of CIAR, and with Dr. J. Fraser Mustard, Founding President, the following points were covered.

1. CIAR is fundamentally concerned about building Canadian research capacity, even though it is not now exclusively Canadian.

2. What holds CIAR's networks together is the common intellectual interest within each program, and the sense of intellectual excitement that comes with shared advances in the particular field. There is also a considerable degree of selectivity; to be designated a CIAR Fellow now carries considerable prestige.

3. CIAR's mission is to transcend disciplines and all parochialism.

4. CIAR is concerned with the development of new knowledge and its wide dissemination; it is not concerned with the application or exploitation of new discoveries. It has no interest in the issue of ownership of intellectual property.

5. A country cannot have knowledge networks without first having people networks. For this and many other reasons, Canada, in its partnerships with developing countries, should concentrate on the areas of health, human development and education.

6. To address the needs of developing countries, Canada's role should be in building knowledge networks consisting largely of experts in the developing countries.

7. Dr. Mustard is presently the Bell Canada Fellow in CIAR, but he is also the President of Founders Network. This consists of over 1000 individuals, each of whom has had some involvement in the creation and development of CIAR. The Founders' Network consists of outstanding scientists and researchers from both universities and government institutions, leaders from the private sector, persons who have held very senior positions in provincial or federal government departments, etc. The Network, in other words, constitutes a remarkable pool of Canadian and international talent, experience, and wisdom. Through CIAR, organizations such as IDRC and IISD should find means of accessing this Network to advance the goals of sustainable development.

8. IDRC in particular would benefit greatly from the development of some long-term relationship with CIAR.

CANARIE—THE CANADIAN NETWORK FOR THE ADVANCEMENT OF RESEARCH, INDUSTRY AND EDUCATION

CANARIE is a network with a technology focus, which is itself, concerned with the development of the "wherewithal" for knowledge networks. It was established in 1993 with funding from Industry Canada; a three-phase approach was adopted with Phase II being implemented over the four-year period 1995-1999. CANARIE is a non-profit corporation in the form of an industry led consortium with over 140 fee-paying members. A 21 member Board of Directors representing private and public sectors governs it; the Board functions in the same manner as any corporate board. The President and CEO is responsible to the Board and manages the staff and operations of CANARIE.

The mission of CANARIE is the development of critical aspects of the communications infrastructure of a knowledge-based society and economy in Canada, and thus to contribute to Canada's competitiveness. It attempts to fulfil this mandate with the support of essentially all of the telecommunications industry in Canada, and does so by financially supporting research and development projects that focus on a marketable product or application development. CANARIE does not fund the basic research that can lead to such products, but rather funds projects that are beyond the pre-competitive stage when a company has been formed but is not yet at the point of going on the market. However, CANARIE does not take an equity position in such companies. To date, approximately 150 projects of this type have been supported following, in every case, a thorough peer review process. Projects in the areas of business research, health care and quality of life, and education and life-long learning are especially encouraged. CANARIE's Phase II builds on the directions of the initial phase and include the:

- Technology and applications development program. This stimulates applications and technology development by financing innovative projects.

- National Test Network, which provides an environment for developing and testing new technology, applications and services that are needed for future broadband networks.

- Operational network upgrade, which will assist CANARIE's evolution to higher capacities to support, expanded applications and services.

> • Outreach program, which helps develop awareness and communicates the benefits of an information-based economy and society in Canada.
>
> CANARIE is, therefore, focused on the development of the telecommunications technologies of the next generation and accordingly is well plugged-in to many other networks, both formal and informal. Among the NCEs, for example, CANARIE is in close touch with TeleLearning, CITR, and HEALnet.

Interview Comments:

The latter points were included in an interview with Mr. Andrew Bjerring, President and CEO of CANARIE.

1. Formal knowledge networks need to be aware of new developments in telecommunications, and plan for their use if they wish to maintain a competitive edge. Internet II will become global and available to all universities shortly, and the next generation of video-conferencing will provide considerable advantages over what is currently available. These are just two of the likely next generation of communication systems, and networks need to be planning now how best to use them.

2. The new technologies will significantly affect research in areas such as health and health care. For example, networks that wish to handle and manipulate a number of large databases in different sites simultaneously will be able to do so, and the sharing of visual information will become routine.

3. CANARIE has had considerable involvement in health care networks; its report, "Telehealth in Canada: Clinical Networks" was published in July 1997: it gives an overview of health-related networks in Canada and demonstrates convincingly the potential of new formal knowledge networks in health-related fields.

4. Mr. Bjerring also emphasized the point that these developments now underway in Canada, could with great benefit be extended by Canada to developing countries.

CIDA CENTRE OF EXCELLENCE
Centre for Human Settlements, University of British Columbia

This Centre is one of six such centres funded through CIDA's Centres of Excellence Program which began in 1990; the Program has now ended, although some of the Centres, including the Centre for Human Settlements, will continue to receive CIDA funding under the UPCD (Tier 1) Program. The Centre for Human Settlements (CHS) has received $5.8 million from CIDA over the past seven years and this has been the only source of funding. CHS is linked with three institutions in China, one in Indonesia, and originally one in Thailand although this has been replaced by an institution in Vietnam; the University of the Philippines is also an associated member. Canadian participation comes largely from UBC, although the University of Toronto, the University of Guelph, and McGill University have much smaller roles.

A CIDA Project Management Committee chaired by the Dean of Graduate Studies at UBC with three other academic administrators comprising the Committee manages the overall project. Its role is to decide on policies and policy-related issues and to monitor project activities. The Project also receives policy advice from the CHS Council, also chaired by the Dean of Graduate Studies, and having six members from within UBC, three from the private sector in BC, and one from each of the partner institutions in China and Indonesia. Communication within the Project is limited to the use of a fax machine, and there is substantial concern about the need for, and cost of, upgrading technology.

The overall theme of CHS relates to urban planning, and the quality of urban life. Under this overall theme, projects are undertaken that address critical policy issues in four Asian cities. The basic intent is to examine social, economic, and physical change throughout: metropolitan regions, inner-city neighbourhoods, and small towns and communities at the edge of the metropolitan region.

The research program is leading to publications, monographs, and conference presentations, as well as a two-way exchange of scholars between CHS and partner institutions. The graduate education and training aspects of CHS have provided opportunities for Canadian students to study in a partner institution as well as students coming to UBC for doctoral study. CHS has also been active in mounting seminars and conferences to create awareness of the project and its research outcomes. Workshops have been held during 1995 in Guangzhou, China, in Vancouver, Toronto, Ottawa, and Montreal, these latter in conjunction with the Federation of Canadian Municipalities. The final research outcomes of the original CIDA-funded Centre will consist of several monographs dealing with growth, change, and policy issues at the metropolitan scale.

Interview Comments:

The following summarizes major points of discussion from an interview with Ms. Elizabeth Zook, Coordinator, and Dr. A. Laquian, Director of CHS.

1. The CHS Project has led to very significant research and publications; much of this would have taken place in any event and there is no evidence that the CIDA funding has led to any significant re-orientation of scholarly interests.

2. The CHS Project has been valuable in broadening experiences it provides for graduate students and also for faculty members.

3. Project funding from CIDA is for too short a period. The development of new research and educational projects takes time before results are discernable. (This is very evident from the NCEs where it has taken at least 7-8 years to achieve a significant degree of success.)

4. Despite the rapid advances in telecommunications over the last 2-3 years, knowledge networks that involve developing countries are still experiencing communications limitations. E-mail is not readily available outside of major centres, and if anything, the communications gap between developed and less developed countries is widening; it certainly shows no signs of being reduced. The experiences of CHS help emphasize the continuing need for modern communications support in development projects.

5. CHS has not experienced great difficulties on the issue of ownership of intellectual property, particularly since CHS is policy oriented. However, such difficulties have been encountered not with CIDA, but with CMHC.

6. CHS's funding from CIDA as a Centre of Excellence has played a major role in obtaining funding for a number of other projects, all dealing with urbanization; this has included projects in Sri Lanka, Australia and the Pacific Basin, and Mexico.

CIDA CENTRE OF EXCELLENCE
Canada-Asia Partnership Program, University of Calgary

Based on the general principles enunciated in its Mission Statement, the University of Calgary has taken specific steps towards greater internationalization; within the organizational structure, the Executive Director of the International Centre now reports to the Vice-President Academic and also carries the title of Associate Vice-President. The International Centre consists of the Division of International Relations, the Division of International Business, and the Division of International Development. This last Division has been designated by CIDA as a Centre of Excellence in Participatory Development. The cornerstone of the Centre has been the Canada Asia Partnership which links the Institute for Primary Health Care of Ateneo de Davao University in the Philippines, the Asian Institute for Health Development of Mahidol University in Thailand and the Division of International Development in Calgary. This partnership does not involve other Canadian institutions, and has not been formalized in any legal sense.

The Partnership has been funded by CIDA in the amount of $5.9 million over the period 1990-1997. This is effectively in the form of a contract to the University of Calgary, and financial and project management is technically in the hands of the University, and operationally in the hands of the Director of the Division.

The objective of the Partnership is to improve the quality of life of people in disadvantaged communities through the process of participatory development. The combined experiences and resources of the three institutions are focused on such problems as income generation through small-scale activities, environmental planning to support sustainable development, communication and organizational processes to enable broad public participation in community management and community planning for better health and nutrition. In the material provided, it is not possible to identify the specific outcomes of this Canada-Asia Partnership, other than (a) the successful development of an academic credit course on Sustainable Communities, now offered annually in Newfoundland, and (b) the offering in November 1997 of the week-long "1997 International Institute on Participatory Development" which is funded by IDRC. However, substantial work is currently underway towards the publication of a monograph which will discuss in detail the results achieved in the Canada-Asia Partnership, as well as its strengths and weaknesses.

The Division of International Development is also responsible for managing the University's involvement in a number of other development projects. These include the Nepal Health Development Project, The Nepal Engineering Education Development Project, as well as other projects in Sri Lanka, Gaza, Latin America, and the Ukraine.

Interview Comments:

The following summarizes most of the points covered in a discussion with Dr. Caryl Abrahams, Director of the Division, Kent Schroeder, Noel Keough, and Gloria Eslinger.

1. Based on their experiences at Calgary, it was recognized that a network can only be established successfully when there is a clearly defined purpose, a well understood theme, and a transparent organizational structure. An example was described of a network established among Canadian institutions for which it became clear, after a time, that it was meeting no recognizable need and that the purpose for its creation had not been well defined.

2. A consortium undertook the Engineering Project in Nepal, which has been very successful, with University of Calgary as the lead institution. This consortium was very strictly formalized at the outset, and this undoubtedly has been a major factor in its success.

3. A very significant part of the Canada-Asia Partnership was, from the outset, seen to be the creation of national networks by each CAP partner. CAP does not claim to have created with each partner a national, single, ongoing, cohesive and well-defined network. However, by incorporating networking into other components of the program, (e.g., workshops, training courses, research components etc., networking with individuals, organizations, NGOs, government departments etc.) was enhanced considerably.

CIDA CENTRE OF EXCELLENCE
Programme d'analyses et de recherches économiques appliquées au développement international (PARADI)

This CIDA Centre is a combined undertaking of Université de Montréal and Université Laval; in 1989, they joined forces in a proposal to the CIDA Centres of Excellence Program for a project in development economics. A grant was awarded in the amount of $5.6 million over five years and the project commenced in 1991. PARADI consists of the two centres of development economics at the two Canadian universities, and about 24 partners in research most of who are university faculty members in African Francophone institutions: all are linked electronically into a network.

PARADI is managed through an Executive Committee consisting of the Director and Co-Director of PARADI, the directors of the two centres at Montreal and Laval, and one representing the researchers in PARADI. In addition, there is a strong international scientific committee that reviews and approves all research applications. These are submitted mostly from researchers at the two Canadian universities but may also include researchers from developing countries. Research proposals are selected on the basis of merit, so that not all are accepted. The research fields covered include methodology and economic modeling, emerging financial economies, macroeconomic policies, and social dimensions. PARADI holds an Annual Conference, and annually evaluates research progress. Research groups meet twice per year, and PARADI also provides assistance for academic visits from developed countries to Africa. PARADI is also active in sponsoring visiting lectures, seminars, and colloquia, (e.g., the symposium on "Business Finance in Emerging Markets" held in Quebec in September 1995). It has also led to a very substantial number of scholarly papers and monographs. In terms of training and education, PARADI in 1995-1996 had five students complete their Ph.D. theses, and 14 completed Masters degrees. PARADI has also offered annually a course for international students on economic policy modeling which has been quite successful. PARADI, then, provides a forum for debate on economic policy issues, helps to provide tools for analysis and measurement, and can help ensure that developing countries are all using the same methodologies.

Interview Comments:

In an interview with Dr. André Martens, Director of CRDE in Montreal, the following points were covered.

1. The CIDA funding for PARADI terminated in March 1998. In the remaining time, PARADI devoted considerable effort to the creation of an extensive set of new databases which participants in PARADI will be able to continue using.

2. PARADI has no links to the private sector and only minor links with governments in developing countries.

3. PARADI has connections with many other networks e.g., Economic Consortium for Research in Africa (Nairobi), IDRC and its networks, World Bank, Network for Analysis of Industrial Policy (Dakar), and Economic Forum (Cairo), as well as links with individuals and groups in France.

4. PARADI is purely academic and has not thought of incorporating; however, with the ending of CIDA funding, it might be possible for it to incorporate and continue its training courses and related activities through contracts with development agencies such as CIDA.

5. To date, CIDA seems to have shown little interest in PARADI or its activities.

6. A major benefit of the type of network that PARADI maintains lies in its ability to serve isolated individuals in small, developing countries.

7. In terms of external communications, PARADI distributes an annual newsletter to about 500 individuals and organizations.

CIDA CENTRE OF EXCELLENCE
INRS, Montreal

A visit was paid to this CIDA Centre of Excellence in Montreal: unfortunately, no printed material was obtained with the result that this description can only be brief and incomplete.

This Centre is focussed on the theme of Urbanization and Development: it was originally funded under CIDA's Centres of Excellence Program in 1990 for a five-year period, subsequently extended to seven years. It will be continuing without break as a project funded under CIDA's relatively new University Partnerships in Cooperation and Development (UPCD) Program. The Canadian component of the network is made up of Groupe interuniversitaire de Montréal (GIP) to which is added four participating institutions in Asia and Latin America. The Centre is under the supervision of a Board, which is decision-making and not just advisory. The majority of its members come from the academic community.

Both in Canada and in its partner countries, the Centre works in good collaboration with governments as well as NGOs, providing expert advice and conducting research on issues relating to urbanization and development. The principal outcome of the Centre's work is a continuing stream of publications and monographs on these latter subjects, although an equally important activity of the Centre lies in the education and training of graduate students. The Montreal Interuniversity Group provides for considerable mobility of graduate students between the various institutions in the Montreal area, and also allows them to work with several different supervisors. This added to the fact that urbanization is itself a multidisciplinary and international theme, ensures an excellent environment for graduate education.

While the Centre is managed through a Board and a Director, there is no other structure; participation in the network of the Centre is fairly loose but efficient, and the technology works well in tying the four developing country centres in with GIP.

The financial support of the Centre from CIDA amounted to approximately $5 million over the seven-year period, and it will be funded by the same amount over the next five years from the CIDA UPCD Program.

Interview Comments:

Additional comments as follows arose in an interview with Dr. Mario Polese, Director of the Centre.

1. Since the Centre is concerned with research on urbanization in all of its aspects, wide dissemination and publication of these results is essential. Much of the research is concerned with policy-related issues and again, wide dissemination and discussion of the results is important. With this CIDA Centre, therefore, ownership of intellectual property is not an issue as it is with the NCEs.

2. The UPCD project will be a direct extension of the work done by the CIDA Centre, although it will be much more teaching oriented.

3. The UPCD project has an integral communications strategy, which revolves around the use of the Internet, as well as of e-mail and fax.

HEALNET
Health Evidence Application and Linkage Network

HEALNet is a multidisciplinary research initiative that brings together over 130 researchers from 17 universities and four research institutes with 22 industrial affiliates. HEALNet's focus is health information, and it aims to make research a more valuable resource in decision-making in the health care system. HEALNet was established in 1995, and it is, therefore, too early to assess or even list its accomplishments; with other NCEs, at least six to seven years have been required to achieve solid results.

HEALNet is managed by a Board of Directors of 17 persons of whom 11 are from the private sector or independent public institutions, and six from universities. HEALNet was granted $8.6 million from the NCE Program for a 3 1/2-year period; 76% of the funding goes to research projects, to date 37 in number. Of the 37 projects funded, 13 are considered to have commercial potential. HEALNet is organized into nine theme teams each under a network leader, with the nine leaders responsible to the HEALNet Program Leader.

Four areas of research are related to information tool development for specific health-care decision-making settings; these are clinical research to link research with clinical practice, health care management, regional health planning, and health in the workplace. The other major themes of HEALNet are Population Health, Health Informatics, and Education and Knowledge transfer. All of these themes relate to HEALNet's basic objective of improving health and health care decisions. The development of new technologies to aid in decision-making, and the commercialization of specific products is an equally important objective.

No information was obtained concerning the criteria for selection of the participants, or for evaluating research proposals or research progress. In material for HEALNet's Annual General meeting in November 1996, there is a realistic assessment by the Program Leader as follows:

> on structure — high marks
>
> on process — high marks
>
> on outcomes — limited success.

Interview Comments:

The following comments were covered in a relatively brief interview with Dr. G. Browman, Program Leader.

1. HEALNet differs from other NCEs in that it is highly conceptual and much less concerned with the development and manufacture of specific physical products. Identification and commercialization of new products such as new health information systems may, therefore, take much longer.

2. The ownership of intellectual property is seen as a considerable difficulty with which HEALNet will have to deal. It has not yet, however, been an actual hindrance.

3. HEALNet is well aware of the international significance, at least potentially, of the research it is undertaking and would welcome international involvements with developed or developing countries; there is already a HEALNet connection with Cuba.

4. To date, HEALNet has been unsuccessful in obtaining direct financial support from any of its industrial affiliates; given its age, however, this does not compare unfavourably with other NCEs at the same stage of development. The most likely sources of financial support are expected to be health care, software, and telecommunications companies.

5. In an interview with CANARIE (see CANARIE description), it was learned that HEALNet is one of the few NCEs that is relating to CANARIE and the development of new generation telecommunications systems. HEALNet has an apparently strong interest in maintaining an effective and forward-looking communications strategy.

INSPIRAPLEX
Respiratory Health Network of Centres of Excellence

On a world scale, respiratory disease is the number one killer, especially in less developed countries. This is so because acute respiratory infections (ARI) are closely linked to nutrition. It is, however, predicted that by 2020 improved food supplies will substantially decrease the global impact of ARI. However, by that time the increasing use of tobacco as a cash crop in developing countries will increase diseases caused by tobacco smoke such as chronic bronchitis and emphysema, coronary artery disease and lung cancer. The establishment of INSPIRAPLEX, which aims to improve the quality of life of patients with respiratory disease globally and to create wealth and jobs in Canada, is, therefore, well based.

INSPIRAPLEX was founded in 1990 and is a not-for-profit corporation; it coordinates 60 projects under the direction of 70 scientists in 18 research centres across Canada. Fourteen universities, four research institutes, three government department/agencies, and seven companies participate in INSPIRAPLEX. There is a Board of Directors of 14 persons, eight of whom are drawn from the business community and the rest from the university community. The Scientific Director reports to the Board and chairs both the Priorities and Resources Committee and the Research Committee; the latter examines and approves all research projects in INSPIRAPLEX, although many of these are funded privately. It seemed clear that the Board accepted the full responsibilities of a corporate board.

The research programs organized under the three vertical themes of inflammation; environmental, genetic, and infectious etiologies; and respiratory pathophysiology. Each of these themes is then addressed through projects, which focus on therapy, technology, and epidemiology. The funding for INSPIRAPLEX for the year ending 31 March 1997, amounted to $2.48 million of which $2.13 million was provided through the NCE Program, $0.177 from industry for sponsorship of workshops and fellowships, and $0.158 million from royalties earned from INSPIRAPLEX commercial products.

INSPIRAPLEX has to date made 22 invention disclosures, filed for 16 patents with five patents issued. It has created six royalty sharing license agreements, and six spin-off companies, which are in various stages of the commercialization process.

Interview Comments:

Major points that were discussed in an interview with Dr. P. Macklem, Scientific Director, and Ms. Anne Vezina, Network Manager are covered below:

1. The actual research budget for INSPIRAPLEX is 80% non-government in the form of private funding for individual research projects.

2. The Network has produced a major cultural shift in the researchers who now appreciate the considerable benefits of collaboration, and who also are increasingly willing to recognize the importance of commercialization.

3. INSPIRAPLEX counts among its research personnel 40 post-graduate students and 46 post-doctoral fellows. The Network provides a superior environment for graduate training and education, especially in comparison to that previously available in university departments. INSPIRAPLEX has established a post-graduate training program in industry, which encourages students and post-doctoral fellows to develop expertise at the interface between university and industry.

4. INSPIRAPLEX has a Public Awareness Committee, which plays a role in the areas of health promotion, disease prevention, disease management and compliance. However, the Annual Report and the interview discussion did not reveal any signs of a developed communications strategy nor an awareness of technology issues.

5. NCEs are likely to weaken universities in the long run, with universities becoming, perhaps, a collection of networks and the landlord of the physical facilities.

6. INSPIRAPLEX fully supports the objective of the NCE Program to be of economic benefit to Canada, but considers that the NCE Directorate ignores the role of the multinational corporations, which are steadily dominating the health field.

7. INSPIRAPLEX clearly has much to bring to sustainable development, and would willingly work with CIDA or IDRC, or any other development agency. It considers that the concept of the NCE as a formal knowledge network is exportable, although the best role for an NCE such as INSPIRAPLEX may well be in graduate education and training.

8. INSPIRAPLEX did not appear to have such well-developed policies in areas such as commercialization, conflict of interest, responsibilities of members etc., as PENCE.

INSTITUTE FOR ROBOTICS AND INTELLIGENT SYSTEMS (IRIS)

This NCE is one of the original networks established in 1990. However, it is quite different from all other NCEs, in that it is privately managed outside of the university system. It is also perhaps the most complex NCE since it involves 138 researchers (members), 21 universities, and 31 industrial affiliates; in total, 69 companies and 26 other organizations are involved in the IRIS Network. Precarn Associates Inc., a member-led industrial consortium, manages IRIS; the Board of Directors of IRIS consists of the Board of Precarn Associates plus several members from the university community. Total membership is 21, of which 14 are from industry, and the remainder from research organizations and universities. The CEO of IRIS is a Director of Precarn and is responsible to the Board of IRIS.

For the year ended 31 March 1997, total revenues for IRIS were approximately $4.8 million, of which $4.5 million was received from the NCE Program. Industry contributions in cash and in-kind totaled $1 million. Of the total cash revenues, approximately $4 million was committed to project and conference expenses. In Phase I of the NCE Program, only 4% of IRIS funding came from industry; in Phase II, 25%, and Phase III is projected to be 40%. However, a continuation of some government funding will be required especially to support the basic research component.

At present, the research of IRIS is defined under four themes. These are Intelligent Computation, Human-Machine Interfaces, Machine Sensing, and Actuation. Each theme is conducted through a number of individual projects and both the major themes and the projects are regularly evaluated and reviewed by the Research Management Committee of IRIS. It is expected that about 40% of these activities will be carried over into Phase III. In preparing for Phase III, 19 proposals were integrated into the IRIS Phase III proposal following a rigorous and comprehensive evaluation including independent Canadian and international experts.

IRIS is very active in technology transfer and in deriving economic benefit for Canada. In Phase II IRIS has generated 30 disclosures, 14 patent applications, and 19 licenses. Additionally, and most importantly, IRIS has created 14 spin-off companies which currently employ 67 persons.

Graduate education and training are seen as important functions. IRIS has set annual targets in both education and training and is successful in reaching them, The number of graduate students and post-doctoral fellows involve in IRIS in 1996-1997 was 287. The graduates who have been associated with IRIS are well received by all employers because of their familiarity with industry and also because of the multidisciplinary nature of the training they have received.

Interview Comments:

The following comments were covered in an interview with Mr. Harry Rogers, President/CEO of Precarn and Director of IRIS. Mr. Rogers is a former deputy-minister in the federal government and was heavily involved in the early establishment of the NCE Program. The interview with him, therefore, covered a wider range of issues than was the case with other NCEs.

1. Confirmation was provided that the key figure in creating the NCE Program was Dr. Fraser Mustard, building on his earlier experiences with CIAR and with the Ontario Centres of Excellence. The NCEs are the perfect political instrument—they are national in scope, they have an economic orientation, they are cost-effective, there is no government interference and judgments are based entirely on standards of scientific excellence as determined by peer review, and they are fully transparent. Since the original objectives were established, the only modification, which was made at the beginning of Phase II, was to increase the emphasis on the industrial context.

2. IRIS and all NCEs are very conscious of the NCE objective of bringing economic benefit to Canada. It was pointed out that this can be difficult with multi-national corporations which show signs of "circling about" the NCEs without much evidence of a willingness to provide financial support. Moreover, such companies may be more interested in economic development of Canadian research results in countries other than Canada. The NCEs must do "due diligence" to ensure that considerable economic benefit does indeed come to Canada. It is for this reason that IRIS is working with small to medium-sized Canadian companies.

3. Although IRIS at present does not see that it has a role in international development, it has already been approached by representatives of Malaysia, Chile, and China all of whom show considerable interest in developing similar networks with the help of IRIS. It is worth emphasizing that the concept of the NCE as a formal knowledge network is itself a "knowledge product" that can bring returns to Canada as it is made available to more global contexts.

4. In the view of IRIS, the NCEs on balance strengthen universities; certainly IRIS is considered to do so.

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE (IDRC)

Networking, defined here as a form of capacity building focussed on researchers, has been used increasingly by IDRC and other donor agencies over the last 25 or so years. It has been actively promoted for a number of reasons, which include:

- facilitation of the exchange of experiences among developing countries;

- promotion of the transfer of Northern ideas, technologies, and funding in a cost-effective way;

- enhancement of local ownership and leadership by creating local centres of expertise; and

- reduction of the risks of capacity-building by spreading out investments over a range of individuals and/or institutions.

Numerous networks have been created, with partners in developing countries and with one or more partner donor agencies; the subject areas embrace some sciences and areas of agriculture, as well as a range of areas in the social sciences and health. Considerable experience has thus been gained by IDRC in the creation and management of networks which facilitate the exchange of knowledge from North to South, from South to South, and from South to North. There is not only exchange of knowledge, but also its creation, with the result that IDRC is widely respected for its networking capabilities.

Virtually all of the networks in which IDRC is involved display the same characteristics. The participants from the South are most likely to be individuals who have previously had, or presently have, an IDRC funded project; this includes both Canadian participants as well as the majority of those from the South. Where the latter participants have not been so involved, their government has most likely nominated them. Certainly the greater majority of the network participants have been selected as individuals, rather than that they happen to represent particular institutions. IDRC usually provides a coordinator who is the key person in the long-term success of a network; the coordinator may be located at IDRC in Ottawa, or may be in a country in the South. The essential requirements of the coordinator are sensitivity to changing local conditions and priorities and also to the researchers needs, as well as good management and human relations abilities. At least at the outset, as the network is established and gains stability, it is the coordinator who meets, on behalf of the network, the accountability requirements of the lead donor agency. An interim steering committee is then created, and only after a period of operation of the network, long enough to confirm a substantial on-going need as well as the credibility of the new network, is a permanent

structure, in terms of a Board of Directors as well as a legal identity for the network, established. Both the interim steering committee as well as a Board is likely to be composed of representatives of the participating countries or institutions, and/or representatives of the donor agencies. The lifetime of a network is obviously linked to the period of time for which funding is provided; there are periodic evaluations of each network, although the basis on which evaluators are identified is far from clear.

The following lists some of the networks in which IDRC is currently involved; some of these and other networks are described in a little more detail subsequently. Current networks include:

- Industrial Support Network Central America
- Sustainable Management of the Uruguayan Coastal Ecosystem: ECOPLATA II
- Coastal Resources Research Network (Asia)
- Bellanet: a Global Forum for Sustainable Development
- Research and Capacity Building
- Latin America Urban Water Management Network
- IDRC – IFIAS Knowledge-Brokering Initiative: Pilot Study
- Medicinal Plants Research Network (South Asia)
- Sustainable Cities (Global)
- Sustainable Andean Development Consortium
- Indigenous Knowledge and Innovation Network
- Community Biodiversity Development and Conservation Program
- Valorizing Vegetable Raw Materials (Africa)

Interviews were conducted with a number of staff members at IDRC, in most cases with Program Officers associated with one or other of the networks in which IDRC is involved. The following paragraphs summarize those discussions, and include both factual materials about specific networks, as well as comments that arose in the course of discussion.

I. Valorizing Vegetable Raw Materials (Africa) (P. Zaya, Program Officer).

This network was commenced in 1993 and follows the usual pattern in that it receives IDRC funding and has a full-time coordinator. The participants are selected individually, and are not just representing a government or institution. A substantial number of the individual projects are concerned with the development of marketable products based on essential oils. The research is not fundamental, but rather directed towards having a tested product at the end of three years. 50-100 products have now been developed.

Comments during discussion were as follows:

a) IDRC itself cannot finance production and marketing of a new product, even though it may initially be on a very small, community-based scale. Some partnerships between IDRC and the private sector both in Canada and the developing country are both desirable and necessary.

b) Attempts are currently being made to interest industry in new kinds of long-term relationships. In at least one project (production of carrageen-based products from seaweed), such a partnership with Canadian industry has been used.

c) IDRC has not been involved in patenting, or other issues of ownership of intellectual property, but there is some recognition that in future it will need to do so.

II. Coastal Resource Research Network (B. Davy, Executive Secretary, Strategy for International Fisheries Research)

This network is a community-based approach to fisheries and fisheries management in Southeast Asia; because of distance, as well as the very different Canadian ecology and climate, the network places considerable emphasis on South-South networking. The participants in this network have either had previous IDRC involvements, or have been selected by their governments; in all cases, there is some prior vetting before individuals are allowed to participate. Management of the network is through the coordinator and a Steering Committee.

Efforts are being made to link the network which is itself very multidisciplinary, to Canadian community-based groups concerned about fisheries management in Canada, and it is likely that some of the new knowledge that will be generated, will be transferable back to Canada.

Discussion comments were as follows:

a) The involvement of the Canadian participants has a sunset clause, but nonetheless such involvement tends to continue for a very long time.

b) IDRC is genuinely interested in the development of partnerships with industry, both in Canada as well as in developing countries.

III.   Bellanet (D. Balson, Executive Director, Bellanet International)

Bellanet is an initiative that originated from the Earth Summit in 1992 in Rio de Janeiro where serious concerns were expressed about the long-term future of aid programs and aid agencies. It was recognized that there was the need for much greater collaboration between agencies, and that the capacity of the donor community needed to be strengthened and sustained. The task of designing a project to assist in the building of this capacity was given to a group of development assistance agencies under the leadership of IDRC, and Bellanet came into existence in 1995. Seven funding agencies are supporting the initiative as it helps to build capacity to use websites, the Internet and various networking and innovative information exchange techniques for supporting collaborative work. There is an International Steering Committee representative of the participating agencies: this sets overall policy, but is otherwise more reactive than pro-active.

Discussion comments were as follows:

a) Participation in Bellanet is entirely voluntary: the degree of commitment is, therefore, variable. Additionally, changes of personnel cause instability and lack of continuity.

b) Of the original 18-20 agencies which took part in the initial discussions, and at that time indicated they would join Bellanet, only eight have done so.

IV.   International Model Forest Network (F. B. Johnson, Executive Director, and K. Dansou, Project Officer)

The IMFN is an initiative in building partnerships locally, nationally, and internationally to generate new ideas and on-the-ground solutions to sustainable forest management issues. Originally started as a Canadian initiative, the network has expanded to include Russia, Mexico, Malaysia, and the United States with more than 25 other countries expressing interest in getting involved. Currently, there are 18 model forests; 10 in Canada, three in Mexico, one each in Russia and Malaysia, and three in the United States.

A common feature of each model forest is the building of working partnerships among individuals and organizations who have an interest in sustainable forest management; the management is, in other words, community-based and the long term goal is to have each community buy in to ownership of the forest and its management.

The Executive Director manages the network with assistance from an international advisory group. Although IMFN is a quite distinct entity from IDRC, the Executive Director of IMFN is responsible to the President of IDRC. CIDA, Foreign Affairs, and IDRC fund IMFN.

Discussion comments were as follows:

a) IMFN is quite unaware of the existence of the Sustainable Forest Management NCE. The latter is probably more science and engineering based, but nevertheless their interests and focus are almost the same and certainly complementary.

MECHANICAL WOOD-PULPS NETWORK
Pulp and Paper Research Institute of Canada

The Mechanical Wood-Pulps Network (MWPN) was established through the NCE Program in 1990, based on a concept developed by senior executives of the Canadian pulp and paper industry. The mission of MWPN is "to develop the technology and expertise that will enable Canadian-based manufacturers to market, world-wide, products which contain improved mechanical pulps or processes and equipment for their manufacture, in order to bring significant economic advantage to Canada and Canadians. This will be achieved through the application of high technology and the training of highly qualified engineers and scientists."

MWPN is governed by a Board of Directors of 13 persons of whom seven are from industry or industry-related research institutes; two are from government, and four from universities. Board membership is now on the basis of four-year terms, which may be renewed once. The Scientific Director reports to the Board, and there is in addition an Executive Director of the Network and a Technology Transfer Manager. The Board has two committees, the Marketing Committee and the Scientific Committee. The Network is focused on six major programs; these are Mechanical Pulping, Bleaching, Yellowing Inhibition, Recycling, Pulp Processing, and Process Control.

There is a senior scientist appointed as Project Leader for each of these themes, and he/she is then responsible for drawing in the necessary expertise. The Scientific Committee reviews all projects and ensures that there is a focused approach to problem-solving.

A major contribution of MWPN is in education and training: in Phase I of the NCE Program, over 100 graduates and post-doctoral fellows completed their training in MWPN, and Phase II (1994-1998) is providing further support for 48 graduate students, 43 post-doctoral fellows and 20 summer students.

The 1995-1996 revenues for MWPN were broken down as follows: 30.9% NCE funds, 40.3% industry (cash and in-kind), 0.1% provincial funds, and 28.7% from universities (cash and in-kind). Over the present four-year period, MWPN will be funded by $12.6 million through the NCE Program, $14.9 million in cash and in-kind from the Canadian pulp and paper industry and its suppliers.

MWPN asserts that the network contributes to both economic and social development. Sales of the first fully-commercialized product, the Fibre Quality Analyzer, have now reached $500,000 annually, and in 1994-1996 marketing of this product created 10 new jobs. A further 15 collaborative

projects are in the process of technology transfer, and all are judged to have a high probability of commercial success. However, while ownership of intellectual property is left with the universities, it is a serious problem for MWPN, as for some other NCEs.

Interview Comments:

The following summarizes the major points covered in an interview with Dr. D. Crosilla, Technology Transfer Manager.

1. MWPN has experienced some difficulty in making the network really function. This is in part due to the size of the network and its geographic dispersion, but also arises particularly with the Board, which includes Canadian companies and multinationals. This difficulty raises an important point about the NCE Program, which places considerable emphasis on benefits to the Canadian economy. National economies are becoming less important in relation to a single global economy, and in any event, a national economy can be less and less determined by a national government.

2. In many of the NCEs, therefore, the likelihood exists that through a partnership between Canadian researchers and a multinational corporation, economic development of the commercialized product may well be conducted by the multinational in a less expensive or more strategic country. Canada will still gain economic benefit in the form of royalties or license fees, but it will be impossible to guarantee that the benefits to Canada can always be maximized.

3. On the opposite side of the above argument is the fact that MWPN has no international ambitions. This reflects the attitude of its Board which does not wish MWPN to do business with foreign companies; to do so might lead to the foreign company gaining ownership to intellectual property, to the disadvantage of the (Canadian) company.

4. MWPN is convinced of the value of the network in graduate training and education, especially in creating a multidisciplinary environment.

5. MWPN has substantial links and on-going projects with other NCEs. In particular, MWPN is collaborating with PENCE on the production of lacasse for pulp bleaching, with the Institute for Robotics and Intelligence Systems, and the Sustainable Forest Management Network. The ability to establish cross-linked teams of national expertise, and thus potentially to create world-leading networks is well demonstrated here.

MICRONET
Microelectronic Devices, Circuits, and Systems

MICRONET is one of 14 federally funded NCEs; it is a Canada wide network involving universities, industry, and government research organizations working cooperatively towards the development of the next generation of microelectronic systems. The network involves 82 professors and approximately 300 graduate students at 22 universities; there are 32 industrial affiliates and four government agencies involved. MICRONET evolved from the Canadian Microelectronics Corporation, an early network which still exists. The original proposal for MICRONET came from 12 researchers across Canada who had not previously been involved in any form of collaboration or networking.

The funding for MICRONET came primarily from the NCE Program; however, the MICRONET Board of Directors at the outset considered that the declining level of NCE funding over the four most recent years would allow only a marginal existence for MICRONET. In 1995, agreement was reached with NSERC that NSERC matching funding would be provided in relation to the level of industrial cash contributions. Thus, in 1997-1998, the total budget is slightly in excess of $3 million, of which $1.89 million is NCE Program funding, $755,000 is from industry, and $420,000 is NSERC funding through the University-Industry Program. Additionally, a further $217,000 has been generated in industrial cash contributions for a short-term research program to address the immediate needs of industry.

A Board of Directors consisting of 10 persons and an NSERC observer manages MICRONET; five members come from industry and five from universities. The Board has overall responsibility for the management and direction of the network, including resource allocation, research program, budgeting, networking, and communications. The Board was instrumental in resolving the funding situation described above, and is clearly a pro-active, corporate-style board. The members of MICRONET are 82 in number and are drawn from 22 universities and four government departments; there are 30 industrial affiliates. MICRONET is not yet incorporated although this issue is frequently discussed. The researchers are grouped into nine regional university centres with each Centre Coordinator reporting to the Project Leader. The research program is monitored and directed by the Coordinating Committee, which reports to the Board of Directors; the Board has overall responsibility for MICRONET. There is also a Business Development and Industrial Advisory Committee which advises the Board of Directors on long term research directions and technology transfer activities. Reporting to the Project Leader is the Network Manager to whom a secretary, the Communications

Officer, and a Technology Transfer Officer in turn report. The Management Centre has developed a comprehensive program aimed at enhancing internal communications within the Network; this includes the publication of a number of documents such as the Annual Report, Workshop Proceedings, a Network Directory, a monthly newsletter, etc. The program also promotes the use of electronic networking, an electronic database conveniently accessible on the Internet, and industry open houses to promote internal linkages.

The research program of MICRONET has focussed on two main components: the Precompetitive Research Program and the Short Term Research and Development Program. The latter is relatively new and seven projects have been successfully launched, each requiring at least 50% funding from the industrial partner, with MICRONET providing the balance. The Precompetitive Program focuses on three highly coordinated themes; each consists of a number of separate projects proposed by researchers but all consistent with the objectives that are set jointly by industrial and university researchers. In 1996, MICRONET generated 291 refereed publications; there have been 25 patent filings from MICRONET and at least three spin-off companies have been formed.

Interview Comments:

The following summarizes some of the points covered in an interview with Dr. A. Salama, Project Leader.

1. The concept of an NCE works extremely well; even in a field such as Engineering, it has led to a marked shift in attitude of the researchers. They have become much more conscious of industry's interests and needs, and are quite willing to re-direct their research accordingly.

2. The influence of the Board has steadily increased and in particular the industrial Board members and affiliates are now much more active in proposing research projects.

3. The Network exercises discipline on researchers; there is regular review of each project, and where it becomes clear that a researcher is more of a "lone ranger" than a "team player", he or she no longer continues in the Network.

4. The ownership of intellectual property continues to be an issue between the Network and the universities, as does the question of sharing overhead funds on research contracts.

5. The Network creates a feeling of belonging, and of being connected. This is one of the few networks that has a well thought out communications plan, although it is largely directed internally. At present, thought is being given to the possible use of video-conferencing as a further step towards improved internal communications.

6. The researchers in MICRONET would like to have effective international connections; the involvement of two Asian companies as affiliates has been raised but has been rejected by the Board which fears that qualified personnel will be lost from Canada, and that intellectual property may also be lost.

7. MICRONET feels strongly that the Network provides an excellent environment for graduate student training and education. The total number of post-doctoral fellows, graduate students, undergraduate students, and research associates involved in MICRONET in 1996-1997 was 337.

FRIENDS OF THE EARTH CANADA

Friends of the Earth (FoE) is an international non-governmental organization which addresses environmental issues and plays an advocacy role in promoting particular solutions. There are National Groups of FoE in many countries, each with an Executive Committee, and from the national Executive Committees the membership of an International Group is drawn. Membership in the National Group is open to any person in Canada interested in the objectives of the organization. Friends of the Earth in Canada is funded very largely through private contributions, with some small government support. However, the funding sources for the National Groups varies quite widely from country to country.

As a specific environmental issue emerges, FoE establishes a research group for that issue; this research group always contains at least one person from the national Executive Committee. As the name implies, this group will undertake research on the issue and will begin the development of a range of policy options. These policy options will be open for discussion and comment from FoE members through the electronic network. The research group, on the basis of their own research of the issue and taking into account the members' comments, finalize a recommended policy option for approval by the Executive Committee.

The FoE network is also an important support tool in the lobbying efforts that FoE then undertakes on a particular issue. It is also used extensively in maintaining contacts with the Canadian Global Change Program and a large number of other environmental networks.

While FoE is a non-governmental organization, and, therefore, is one voice from the general population, it interacts extensively with government and government agencies. It also, however, interacts with industry, although the success of such interactions is usually determined by the degree of receptivity demonstrated by industry. For example, FoE has worked with some corporations in the development of a statement of ethical principles relating to environmental preservation.

Comment:

The above material is based on an interview by telephone with Ms. Beatrice Olivastri.

GREENPEACE CANADA

Greenpeace Canada is a particularly successful Canadian non-governmental organization. It is part of Greenpeace International, which is the umbrella organization for all national Greenpeace groups. While there is a board of Directors for Greenpeace International, it is a governance board, and the International Council consisting of one trustee from each participating country is responsible for determining the priority areas that will receive Greenpeace attention. At present, these global issues are:

- climate change
- biodiversity
- toxics in the environment
- the nuclear industry and use of nuclear energy

Each country organization then works within these areas according to its capabilities and resources, although these decisions are taken jointly by Greenpeace International and Greenpeace Canada in order to achieve consistency and avoid duplication of effort.

Greenpeace Canada has its own Board of Directors which is strictly a governance board, with the carrying out of the Greenpeace mission and the conduct of day-to-day operations left fully to staff. There is an Executive Director who oversees a number of separate departments run by staff. For each major issue that Greenpeace becomes involved with, a Campaign Director is appointed from the staff. Greenpeace Canada is supported entirely by private, individual contributions—Greenpeace will not accept financial support from governments or from corporations. At present, Greenpeace Canada has approx. 130,000 donors, of whom at least 16,000 contribute through monthly payroll deductions; all donors are defined as members of Greenpeace. However, the only voting members are the members of the Board of Directors.

The work of Greenpeace Canada falls under two headings: development of policy options on environmental issues; and enhancement of public awareness.

In developing policy options, Greenpeace Canada will undertake its own research of existing knowledge on a particular issue, but it may also sponsor through contracts specific pieces of research in areas where knowledge is lacking. The Campaign Director is responsible for pulling together all research on an issue and drafting policy options. Greenpeace Canada itself certainly generates and disseminates new knowledge; for example, much of its research on Antarctica is quite original. On major environmental issues, the official Greenpeace position is determined by the Board of Greenpeace International,

based on the research brought together by Greenpeace and consideration of the recommended policy options.

In terms of technology, communication is generally by e-mail although there are also annual meetings of national Campaign Directors and other periodic meetings. Greenpeace Canada maintains links with the Canadian Environmental Network, and a number of other similar networks. Curiously, however, there seem to be no links to either the Canadian Global Change Program or the Canadian Network of Toxicology Centres.

Greenpeace Canada has developed an extensive and effective communications strategy, which has several components:

a) Donors – three or four mailings are sent out per year to all donors, to keep them informed about Greenpeace activities. Each mailing goes to approx. 70,000 persons.

b) Publications – there is a steady stream of Greenpeace publications. In each case, care is taken to ensure that it is directed to the most relevant target audience—publications are not distributed through one general mailing list.

c) Media strategy – Greenpeace keeps in constant touch with the media and has been remarkably effective in getting its message across through all forms of media.

d) WWW site – Greenpeace has a www site, which is widely accessed and is steadily expanded.

e) Lobbying – this is an ongoing daily activity of Greenpeace Canada. There are frequent meetings with Ministers of the Environment, parliamentarians, bureaucrats, etc. It is widely recognized that Greenpeace has gained considerable credibility and is especially effective in raising awareness of environmental issues.

f) Industry – while Greenpeace will not accept financial contributions from the business sector, it is prepared to work with industry. For example, at present there is ongoing work by Greenpeace and approx. 12 companies regarding the use of fossil fuels. Even this involves some degree of confrontation, and other companies have completely refused to work with Greenpeace.

Comment:

The above summarizes an interview conducted by phone with Ms. Jeanne Moffat, Executive Director, Greenpeace Canada.

MINES ACTION CANADA

Mines Action Canada (MAC) is a coalition of non-governmental organizations committed to the complete abolition of landmines. Although it is stretching the description that has been given to a formal knowledge network, it is useful to include this network in view of its obvious recent international success, and also because its operation has been very much at the grass-roots level. The initial lobbying efforts against land mines commenced in 1991, but the formation of MAC as a coalition did not occur until 1994. Its long-term existence is, at the moment uncertain, and will largely depend on the outcomes of the international treaty conference in Ottawa in December 1997.

MAC is presently a coalition of some 45 official members all of whom have formally endorsed the landmines declaration. Additionally, another 143 NGOs support the coalition but do not have official membership and, therefore, no voting privileges. The regular MAC mailing list also contains the names of another 500 persons. It is not possible to obtain an estimate of the number of individuals who have participated in this work, but it may well be in the hundreds of thousands.

Communication to the participating organizations is by e-mail together with some periodic mailings. There have been a number of direct mailings to Cabinet Ministers and Members of Parliament—all of these have originated in the MAC office in Ottawa. MAC does not have a formal communications strategy.

MAC is governed through a Steering Committee composed of representatives of a small number of the key NGOs. There is a full-time coordinator and permanent office in Ottawa. Funding for MAC has come in lump amounts from several of the member organizations, from a Canadian foundation, and more recently from an American foundation; in earlier years, there was some small federal funding.

MAC sees its role as two-fold: advocacy and lobbying; and raising public awareness. In both activities, action occurs at the grass-roots level. MAC will distribute policy statements to all participating organizations and ask that there members take action on them. This may be in the form of letters to local members of parliament, obtaining signatures to a petition, etc. MAC has continuously emphasized that the debate on use of landmines must be kept as simple as possible. The issue is a very straightforward humanitarian one and must not be complicated by debate over possible exceptions or other technical or political issues. It appears that, by keeping the issue very black or white, and by having such an enormous grass-roots effort, the network of MAC and its allies has achieved considerable success.

Comment:

The above material is based on an interview by phone with Ms. Celina Tuttle, Coordinator of Mines Action Canada.

INTERNATIONAL FEDERATION OF RED CROSS AND RED CRESCENT SOCIETIES (IFRC)

IFRC is included in this study of networks largely to emphasize that there remains an enormous gulf between the quality of life we enjoy in Canada, compared with that in many other parts of the world. IFRC is made up of 169 national societies around the world, including that in Canada, with a coordinating Secretariat in Geneva. Its mandate relates specifically to disaster relief, and the overall vision is to reduce human suffering. The Secretariat employs some 270 people in Geneva and has more than 400 delegates and 1500 local staff in the field. National societies can call on the Federation Secretariat for help in the event of a disaster. The Secretariat then launches an international appeal to other national societies and coordinates the people, money and materials that are donated. Networking is recognized as a significant asset in improving disaster management for both the Federation and the National societies.

Previously, communications in the Red Cross and Red Crescent structures were mainly concerned with the use of radio, telephone, and telex services. Indeed, many of the telecommunications delegates were radio amateurs or former military personnel who had been trained primarily in radio communications. The Federation has long recognized the importance of information management and data communications in its disaster relief work, and in 1991, with financial aid from CIDA, undertook a project to upgrade computer facilities, to create specialized databases, and to set up an Information Resource Centre and Information Systems Department. In January 1996, again with CIDA support, the Federation commenced the second phase of this work to establish a global Red Cross/Red Crescent network linking the Secretariat, the national societies and the Federation's delegations. This is expected to take 3-5 years for completion.

The major difficulty lies in the fact that modern telecommunications are not universally available. National societies in the North have reasonably good technological tools but those in the South are usually poorly equipped and often have limited resources. In the North, the Secretariat had all personnel in Geneva on the Internet by early 1995, and in 1996, 26 national societies had Internet access. In 1997, at least 30 national societies have their own website. However, the majority of national societies and most Federation delegations are in developing countries, so there is a clear need to implement a communications strategy in these areas. Access to the Internet is growing much more rapidly than had originally been expected; at present, at least 30 of the 36 countries in Africa have Internet access. However, it is often not reliable, and in any event this too frequently means that access is available in the national capital, but in the rest of the country, telecommunications is still in a primitive state, and in places still non-existent.

The development of this project will focus on two major areas of activity: information management; and data communications. The first component, information management, will provide the first fully international opportunity to define the specific types of information that are required for the disaster relief effort. This information has to come directly from the field, but must then be systematically organized and collected. Eventually new systems applications, adapted specifically for fieldwork, will be developed as a result of this project. Also, the federation aims to provide packages of information to delegates before they arrive on the disaster scene. Some of the information including Federation policies, procedures and country-specific information such as maps will probably be made available on CD-ROMs. It seems clear that, when fully implemented, this project will provide much new knowledge about disaster relief and will help ensure timely and appropriate responses.

The data communications component will focus on the development of a telecommunications network principally using e-mail. Under disaster conditions, this is often difficult in the field. The Federation has used since 1994 high frequency links using PACTOR—a radio modem for data transmission—to connect remote locations to e-mail services in Geneva. This was especially successful during the Rwanda crisis to send situation reports and requests for assistance. The Federation has also explored the possible use of non-synchronous, low-earth orbit satellites (LEOs) that can provide continuous communications coverage over the earth's surface, and also utilizes X25 data networks, the Internet, satellites (Inmarsat M and MIni M primarily), radio (HF / VHF /UHF Voice), HF slow speed data (PACTOR) etc., and often has to do so under difficult conditions. The challenge is to create from this diversity a genuine network.

Comment:

Linda Stoddart, Director of the Information Systems Department, IFRC Geneva drew the above material from a paper. It was kindly made available by Dr. John Black.

NEUROSCIENCE
McGill University

Neuroscience was one of the first group of NCEs established in 1989; indeed, the birth process seems to have been somewhat longer than for others since it was the end of 1990 before Neuroscience was functioning. In 1995 (the latest year for which an annual report was available), Neuroscience comprised over 200 investigators from 18 universities and research institutes across Canada. Neuroscience itself is not incorporated, but is still governed by a Board of Directors of 17 persons of whom seven are from the private sector, and the remainder from universities or the network itself. Responsible to the Board are the Scientific Director, the Executive Director of the Network, the Management Committee, the Scientific Advisory Committee which includes non-Canadians in its membership, and the Commercialization Advisory Committee. The Board now functions very much as a corporate board and has been particularly active in strategic planning for Phase III.

In order to provide focus and especially to ensure critical mass, the research of Neuroscience is organized around six themes, which are:

- Rescuing and protecting nerve cells: neuronal survival and protection

- Food for nerve cells: neurotrophic factors

- Blocking the blockers: inhibitors and enhancers of neurite growth

- Rewiring the circuitry: regrowth and reconnection in the nervous system

- Newest tools for brain repair: gene technology: gene therapy

- Electronic replacement parts: functional recovery

In some aspects at least, there is a close relationship between Neuroscience and CGD Network. The Scientific Advisory Committee reviews all research regularly for quality and relevance.

Unlike some of our international competitors such as France and Germany, Canada does not have a viable neuroscience-based industry. However, Canada does have an international reputation for excellence in neuroscience research, ranking amongst the top 6 or 7 countries in the world. The creation of the Neuroscience NCE presented the opportunity to convert this substantial Canadian intellectual resource into an internationally competitive domestic industry. Neuroscience is, therefore, different from other NCEs in a number of ways. First, in the absence of a Canadian neuroscience industry, the private sector involvement in Neuroscience drew quite heavily on the finan-

cial community, since investment in a new industry must be a critical first step. Second, instead of appointing a Technology Transfer Manager, Neuroscience appointed an Executive Director with considerable experience in the banking community. Neuroscience itself is not incorporated, but it has created a separate company, Neuro Research Inc., to serve as the legal entity handling the Neuroscience Partners Fund and to handle formal relationships between the Network and its industrial partners. In the absence of a pre-existing neuroscience industry in Canada, the Neuroscience network sees its role as two-fold: the development of a still stronger and more dynamic research base in neuroscience, and then the implementation of a rigorous strategy to build a neuroscience-based industry in Canada. The strategy developed by Neuroscience recognized the need for funding for "discovery development" and for the early stages of creation of a new industry. The financial community was, therefore, approached to invest in a special fund dedicated to the development of neuroscience discoveries with commercial promise. The Neuroscience Partners Fund currently has a total investment of about $54 million and the intent is to increase that to $100 million. Some selective investments from this fund have been made in established neuroscience companies, some of which are establishing subsidiaries in Canada. Neuroscience has also led to three licensing agreements, and at least one spin-off company, with eight more initiatives, all of which may lead to separate new companies, at various stages of the commercialization process.

Neuroscience is heavily involved in graduate education and training. In 1995, 57 graduate students and 35 post-doctoral fellows received Network support, 28 trainees attended courses in Tissue Culture and Electrophysiology, and 42 trainees attended Network workshops during the course of the year.

Interview Comments:

The comments below describe the main points covered in an interview with Dr. David Johnston, Chairman of the Neuroscience Board, and Mr. Warren Bull, Executive Director of Neuroscience.

1. Neuroscience is a multidisciplinary field that universities have difficulty in handling within a departmental structure. The creation of the network gives neuroscientists a community and an intellectual home. The multidisciplinary nature of the network as well as its multi-institutional character provide a superior environment for graduate studies, as well as the possibility to offer workshops and training courses that does not usually exist in the universities.

2. The view is held that what holds a network such as Neuroscience together, what cements it, is the availability of new research funding combined with the ability to more easily conduct research on cross-institutional lines.

3. Neuro Research Inc. differs from nearly all other corporations that have been formed within or by other NCEs. Because of the lack of a Canadian neuroscience industry, Neuro Research Inc. will hold a share of equity in all spin-off companies. This is seen as one part of ensuring economic benefit to Canada from the NCE, and also part of the establishment of a Canadian industry.

4. Ownership of intellectual property is seen as a major problem, although further discussion made it clear that the problem does not necessarily lie with universities' policies on ownership of intellectual property, but more with the inflexible interpretations that Technology Transfer Offices within the universities apply to the policies.

5. The importance of a well-developed communications strategy is recognized by Neuroscience. In addition to the use of electronic means of communication within the Network, Neuroscience also publishes newsletters (approx. 2000 copies per issue), videotapes, and has held fairly regularly a series of media sessions.

6. There are no substantial international links, and given the very sophisticated nature of neuroscience, it is unlikely that such links could be developed with any other than advanced countries. There are at present some recognized links with Japan.

ORBICOM

The World-wide Network of UNESCO Chairs in Communications

ORBICOM is an international network that links communications leaders from academic, media, corporate and government circles with a view to providing for the exchange of information and the development of shared projects. It is based on the belief that communication is a pillar of any democratic society and an essential means of spreading skills and knowledge. The ORBICOM network is an apolitical, neutral organization open to all streams of thought and opinion. ORBICOM consists of 15 Chairs in Australia, Brazil, Bulgaria, Canada, Colombia, Hungary, Ivory Coast, Kazakhstan, Lithuania, Mexico, Russia, Spain (two), and Uruguay—there are 165 members spread across 50 countries. Ultimately, ORBICOM will embody a network of 300 associate members and 25 UNESCO Chairs in Communications around the world.

A Board of Directors, appointed by UNESCO governs ORBICOM; the Board is solely responsible for the intellectual and scientific directions of the network's actions and programs. The Board presently has 15 members of whom nine are from universities and the others from the communications industry and UNESCO. The Board functions largely in an advisory role and is "hands off". Funding for each of the Chairs is obtained entirely from the home country; in Canada, Bell Canada is a major supporter. In other cases, industrial support may be provided for a specific ORBICOM project or activity. The activities of ORBICOM include:

- the exchange of knowledge and expertise in communications through education, research and concrete action;
- link specialists in different communications sectors;
- set up training and internship programs to improve communications capabilities;
- establish exchange programs for professors and specialists;
- develop publications and conference programs; and
- provide expertise and consulting services to international organizations.

Interview Comments:

The following points were covered in an interview with Ms. Thérèse Paquet-Sévigny, Secretary General of ORBICOM.

1. The chief objective in founding ORBICOM was to strengthen the communications field in both North and South, by creating a network that is both multidisciplinary and multilingual.

2. The focus of ORBICOM is more on the technology than on policy although both are included in ORBICOM's activities. The availability of technology particularly in the South causes some difficulties, as illustrated by a proposal from one African university that wished to establish a Chair in its Medical School since it was only there that the required technology was available.

3. There is no long-term, strategic plan for ORBICOM's work. Since the Chairs are all funded quite separately, this is not surprising. However, it was claimed that, in the absence of such a plan, ORBICOM is able to respond more quickly to unanticipated needs.

4. ORBICOM has already had working relationships with CIDA on a project relating to women's issues, and has also had some involvement with IDRC in institutional strengthening projects. Since ORBICOM from its inception has been concerned about North-South issues, it has a natural interest in becoming more involved as the network reaches maturity in sustainable development projects.

5. ORBICOM believes strongly that it is money that makes networks work successfully. Nevertheless, more needs to be done to study networks and the way in which they work, and to analyze data concerning communications that a network creates for either internal or external use. In addition to having the communications technology, it is also necessary to understand the culture of the country or region.

PENCE
Protein Engineering Network of Centres of Excellence

PENCE is one of the original NCEs and is, therefore, seven to eight years old and entering shortly its third phase of funding. It is a research network of Canadian researchers from university, research institutes, government and industrial laboratories which is concerned with the determination of the molecular structure of proteins by a variety of techniques, with an increased understanding of the function of proteins, and with the use of genetic engineering and chemical synthesis of peptides.

PENCE is managed by a Board of Directors of 14 persons, of whom five are drawn from the private sector. Interestingly, the Board includes a representative of the legal community, and also a member from the venture capital financial sector. The by-laws of PENCE require that one representative come from the financial sector and has experience in financing technology-related enterprises. The Board is the executive authority of PENCE, and provides guidance and advice as well as accepting responsibility for policies, finances, and all business. PENCE has recently been incorporated as a not-for-profit corporation and has developed a very thorough and detailed Members' Agreement. In addition to stating the By-laws of PENCE Inc., the Agreement provides complete details and guidelines for the activities of PENCE committees and for administrative matters; it also gives an organization chart, and appendices that describe in detail policies on issues such as confidentiality, responsibilities of participants, conflict of interest guidelines, guidelines for commercialization, and working guidelines on "benefit to Canada", etc. PENCE has probably benefited by not incorporating until very recently; this has given it the advantage of drawing on the experiences of other NCEs that incorporated at earlier dates. The PENCE Members' Agreement is almost certainly the most recent, most detailed, and most refined such document for a formal knowledge network in Canada.

The Network Leader (Scientific Director) functions as CEO and reports to the Board; the research Theme Leaders and PENCE management staff are responsible to the Network Leader, who also chairs the Management and Science Planning Committee and the Technology Assessment and Planning Committee. The management staff of PENCE includes a Network Manager and a Manager of Business Development. The selection of participating scientists is based on strict criteria and high standards. Scientists propose individual or joint projects which are vetted by the Management and Science Planning Committee; an obvious consequence after six years or so of experience is demonstrated by the fact over 75% of recent scientific publications are from two or more of the participating institutions. As projects are finished

and the direction of the science evolves, there is some turnover amongst the scientific participants; it is estimated that during its existence, there has been an approximate 30% turnover.

PENCE has to date had 25 patents issued and has approximately 50 more patent applications pending.

Interview Comments:

Major points that were covered in separate interviews with Dr. G.E. Connell, former Board Chair, and Mr. J. Chivers-Wilson, Network Manager.

1. PENCE was originally built around the scientific interests of Nobel Prizewinner Michael Smith and of Michel Chretien, but has since evolved considerably. In the early years, it was mainly oriented to leading edge fundamental research, and was relatively weak on the commercialization side. More recently, there has been a major shift with greater emphasis on commercialization; the Board and especially the industrial members have become much more influential, and there has been a very significant "cultural shift" among the participating scientists. The latter now understand and appreciate the interests and directions of industry, and are much more willing to re-direct their research accordingly, but without relinquishing their commitment to fundamental research.

2. The view is strongly and unanimously held that the network adds value that cannot be achieved by the same scientists working independently.

3. PENCE as a formal knowledge network is an enabling mechanism to a much greater degree than other NCEs; it also has achieved a good balance between fundamental and applied research projects.

4. PENCE has recently created PPFI (PENCE Patent Financing Inc.) as a separate spin-off company to deal with the pre-competitive stage of commercialization of PENCE scientific discoveries. The Bank of Montreal finances PPFI.

5. While ownership of intellectual property is still seen as a major issue, it may have been largely resolved by the preparation of the Members' Agreement described above.

6. PENCE and other NCEs are seen as being of benefit to universities especially in terms of bringing research facilities that could not otherwise be obtained. However, NCEs are also seen as "pan-Universities" in the sense that they transcend departmental boundaries, are genuinely multi-disciplinary and provide a very superior environment for graduate student training and education.

7. The recent incorporation of PENCE was undertaken for several reasons: firstly to increase the credibility of PENCE in its relations with industry, secondly for legal reasons relating to issues such as liability etc., and thirdly, so that PENCE could enter into proper legal arrangements for joint ventures with the universities as partners.

8. PENCE is confident that over the next seven years it can move to financial self-sufficiency. It should be noted that the 1996-1997 financial statement for PENCE indicates that total income was approximately $7.25 million, of which $4.5 million came from the NCE Program, and $2.75 million from industry, provincial governments, research institutes, and one or two international sources.

SUSTAINABLE FOREST MANAGEMENT NCE
University of Alberta

The Sustainable Forest Management NCE (SFM) was established in 1995 and is still in a relatively early stage of development. The aim of SFM is to develop strategies that align economic and environmental objectives to ensure that: Canada's boreal forest is effectively managed; its biological diversity preserved; and its resources sustained for future generations.

A key element is understanding the role of Aboriginal communities in the boreal forest. The forest management strategies and environmental technologies that result from SFM research will be marketable worldwide.

The research program of SFM has four main themes:

- Ecological basis of sustainable forest management;

- Minimal impact techniques for forest materials processing;

- Socio-economic sustainability; and

- Planning and practices for sustainable forest management.

The SFM Network thus links natural scientists in forestry, soil science and biological sciences with social scientists in economics, sociology, anthropology, health sciences, law, political science and environmental, civil and chemical engineers and further links them all with stakeholders in industry, government and the public.

The SFM Network is governed by a 17-member Board of Directors representing a cross-section of groups with a vested interest in how Canada's forests are managed. The Program Leader reports to the Board and is assisted by the Research Management Committee; the latter reviews critically all project proposals under each of the four major themes and also monitors progress. There is a Network Manager and also an industrial liaison officer who is responsible for developing industrial ties and opportunities for collaborative research. A theme co-leader heads each of the four themes of the research program and is responsible to the Program Leader.

The financial overview of SFM for the period ending 31 March 1997 shows that total annual income was approx. $5.16 million, of which $3 million came from the NCE Program, $0.75 million from provincial governments, and $0.89 million from industry; the balance was from miscellaneous sources and a carry-forward from the previous year.

Interview Comments:

Important points covered in an interview with Dr. Bruce MacLock, Network Manager, are summarized as follows:

1. The SFM Network is not in the business of developing "widgets"; it is producing enabling knowledge based on an overall theme that was developed over a three-year period.

2. SFM is not heavily involved in issues of intellectual property and does not expect to be in the future. It is also not incorporated and is not likely to be.

3. SFM is remarkably multi-disciplinary, although it is probably too early in its history to assess the degree of success being achieved. It is also quite different from what might have been developed in industry alone, and it seems already clear that SFM is changing industry and industry values.

4. The relationship with industry was somewhat strained at first, but industry now looks on their involvement as a necessity in order to be able to obtain certification. The overall attitude of industry towards SFM is steadily improving.

5. SFM has what is claimed to be a highly proactive communications and marketing program. This includes participating in technology transfer conferences and trade shows, as well as the creation of databases, use of the Internet and the Canadian Technology Network, and awards and publications programs.

6. It is projected that, presumably in its present phase of federal funding, SFM will produce approx. 15 patentable inventions, 15 software programs and marketable ecological expertise, with the negotiation of nine viable Network licenses with companies across Canada.

7. SFM has considerable interest in developing international links; it is currently developing plans for a similar network in Russia, which is the other country with extensive boreal forest. However, the concept of a sustainable forest management network can be applied in almost any other country, although the technical content would need to be adapted. There have already been quite informal contacts with China about the possibility of assistance from SFM in establishing a similar network in that country. It is, however, quite surprising to find that the SFM Network and the International Model Forest Network associated with IDRC do not seem to be aware of each other's existence.

8. SFM provides an excellent model for training highly qualified personnel; it is expected that the program will train 50 postdoctoral fellows and approx. 140 Ph.D. and Master's students across institutional, disciplinary and sectoral boundaries. In addition, it is expected that by the third or fourth year of the Program, undergraduate courses spanning the eight faculties involved in this environmental research will be introduced at the participating universities.

TELELEARNING NCE

The TeleLearning NCE is a national collaboration linking Canadian researchers and client communities involved in the development, application, and evaluation of advanced education technologies based on collaborative learning and knowledge building. Over 130 researchers from education, the social sciences, computer science and engineering from 30 universities are working with client communities. TeleLearning is a relatively new NCE, having been officially inaugurated in November 1995; it is still in the formative stages, and its accomplishments still embryonic.

A Board of Directors consisting of nine founding members and nine more recent members manages TeleLearning; of the total membership, at least 12 are from the business sector. Financial support to TeleLearning of at least $20,000 annually is accompanied by membership on the Board. The Board is responsible for all financial aspects of TeleLearning, and also determines the major research themes. There are currently seven themes:

- Learning models

- Socio-economic models

- Systems models

- K - 12 Education

- Post-secondary Education

- Workplace and Continuing Education

- Educating the Educators

The first three themes are foundation themes that support the other themes. Within these seven themes, there are currently some 56 projects underway. Each project is based on a submitted proposal, which is reviewed by the Program Committee for its quality and relevance to the total program.

The research of TeleLearning is organized around four beacon technologies: CSILE (a networked system to support collaborative learning and inquiry from the primary grades to university), TELEFORM (tools for delivering telelearning to the workplace and home), VIRTUAL-U (an online learning environment for designing and authoring courses on the Internet), and CADRETel (a set of design and authoring tools and methodology for creating learning support systems). These four technologies have the potential to become the software environments within which technology-based education and training will take place in the future.

TeleLearning has very recently been incorporated as a not-for-profit corporation.

Interview Comments:

The following were points covered in an interview with Mr. John Vekar, Knowledge and Technology Transfer Manager for TeleLearning.

1. The research participants in TeleLearning became involved through informal networking; there is no indication that any criteria based on merit were involved, although it seemed apparent that individual projects have been critically reviewed.

2. The ownership of intellectual property is recognized as a future problem with which TeleLearning will have to deal. To date, the Board has not taken a position on the matter.

3. TeleLearning is one of the few NCEs that is keeping itself informed of other Canadian formal Networks. CANARIE Inc. is a full member of TeleLearning, and there are established links between TeleLearning and CIAR's Human Development Program, and between TeleLearning and the Bank of Montreal's Institute of Learning.

4. There is considerable TeleLearning interest in international collaboration, and the Executive Committee of the Board is presently discussing the desirability of links with organizations such as the Open University in the U.K. However, it is also appreciated that the outcomes from TeleLearning research might well have global application.

5. TeleLearning provides a very appropriate environment for graduate education and training; it is estimated that about 50 such students are presently involved.