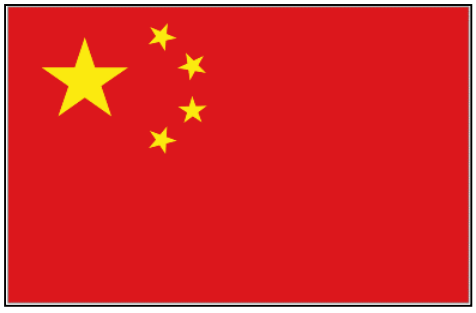
CANADA – CHINA SCIENCE AND TECHNOLOGY (S&T)

COMPLEMENTARITY STUDY

A Joint Study on Enhanced Cooperation between

Canada and China in S&T

FINAL REPORT



CANADA – CHINA S&T COMPLEMENTARITY STUDY

A Joint Study on Enhanced Cooperation between Canada and China in Science and Technology

FINAL REPORT

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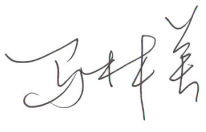
FORWARD

On behalf of the team of Canadian and Chinese experts who conducted the Canada-China S&T Complementarity Study, we are pleased to submit this final report. The report sets out recommendations for further strengthening the vibrant S&T relationship existing between the two countries today, including through focusing on four priority areas and drawing on effective modalities and mechanisms for S&T cooperation under the Canada-China S&T Cooperation Agreement.

The Canada-China Expert Study Team extends its sincere thanks to their hosts in China and Canada, whose generous hospitality made the team's study visits highly informative and productive.

During these visits, the Expert Team benefited from the knowledge, experience, and considered views of: leading business persons and their technological and scientific research staffs; leading academic scientists and researchers working at the frontiers of science; and many other scientists and researchers working within government and non-governmental research facilities. The Expert Team is most grateful to them for their valuable contributions to the study.

As co-chairs of the Expert Study Team, it has been our honour and privilege to work with a highly talented, knowledgeable, and motivated team of colleagues: Dr. John MacDonald; Dr. Laurie Hing Man Chan; Dr. Li Shujun; and Dr. Lun Jingguang. They applied their expertise and in-depth knowledge of the Canada-China S&T relationship through all phases of the study program. In addition, we extend our thanks to Ms. Vanessa Chang and Mr. Wang Qiang who took care of the Expert Team during the study tours.



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December 2006

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EXECUTIVE SUMMARY

The Prime Minister of Canada and the President of the Government of the People's Republic of China, in their *September 2005 Declaration on Science and Technology Cooperation,* directed that a study of Canada-China Science and Technology (S&T) complementarities be undertaken to help support the implementation of the Canada-China Cooperation Agreement on Science and Technology.

The resulting Canada-China S&T Complementarity Study sets out recommendations for further strengthening the already vibrant S&T relationship existing between the two countries today.

The Expert Team concludes that the government-to-government cooperation under the Canada-China S&T Agreement should focus on issues where S&T research would have great social and economic benefit to both countries, as well as the world at large. Governments should focus on assistance in places where marketplace mechanisms sometimes fail to allocate resources effectively or deliver public goods of common benefit. For example, Small and Medium-Sized Enterprises (SMEs) may often lack the information and resources to find and engage international partners. This is an area where government can play an important enabling role.

Specifically, the joint Canada-China Expert Team recommends that:

1) Two tiers and four areas should be the initial focus under the S&T Agreement:

    - Tier 1: Environment and Energy
    - Tier 2: Health & Life Sciences / Biotechnology and Agricultural Foods & Bioproducts

2) Modalities of Co-operation should include:

- Building linkages and partnerships;
- Supporting the development of young researchers;
- Engaging SMEs; and
- Joint infrastructure - including virtual and actual laboratories.

The Expert Team finds that there are synergies between the priority areas chosen. For example, renewable energy sources overlap both the energy and the environmental areas while sustainable agriculture and biofuels overlap both the agricultural, energy and environmental areas. As well, these four priority areas should not preclude from future consideration other areas for potential Canada-China S&T cooperation.

The Expert Team recommends that government support for cooperation be focussed on creating linkages and partnerships. The primary role of the government should be as a facilitator and enabler, bringing together the key players in the three main R&D performing sectors: university, industry, and government. Government should support the efforts of these sectors to strengthen Canada-China S&T partnerships. The goal of these partnerships should be to produce research results that will benefit the public good.

The Expert Team finds that benchmarking and measuring progress is a critical element for successful implementation of the Canada-China S&T Cooperation Agreement. While they discussed some possible indicators, in broad terms, they concluded that more analytical work will be required in this area.

By working together, with mutual respect and through cooperative S&T endeavours, Canada and China can make a real difference to the lives of their people, as well as for all people throughout the world.

CANADA – CHINA S&T COMPLEMENTARITY STUDY

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Introduction

The governments of Canada and the People's Republic of China recognize that science, technology and innovation are central to raising productivity, the standard of living, and the quality of life of their citizens. The promotion of S&T, including through cooperative and collaborative activities between the two countries, is an important means to help both countries achieve their respective economic, social, environmental, and international objectives.

In September of 2005, the President of the People's Republic of China and the Prime Minister of Canada recognized the opportunity to extend and strengthen the Canada-China S&T relationship in areas of common interest, and encourage the application of the results to the economic, social and environmental benefit of their citizens and the world at large. At that time, they issued a *Joint Declaration in Science and Technology Cooperation between the Government of Canada and the Government of the People's Republic of China*, setting out the intent of the two governments to enter into an agreement on cooperation in S&T to:

> Encourage, develop and facilitate cooperative activities in science and technology for peaceful purposes, in fields of common interest and on the basis of equality and mutual benefit between Canadian and Chinese governmental and non-governmental entities, including private sector firms.[1]

The Joint Declaration provided that the two countries conduct a joint S&T complementarity study to identify mutually advantageous S&T priority areas and the modalities and mechanisms for achieving mutually beneficial results through the framework of a Canada-China S&T Cooperation Agreement.

This final report is the culmination of the complementarity study program undertaken by a joint team of Canadian and Chinese experts (the Expert Team) appointed by their respective governments. The Expert Team included six representatives, three from each country. A senior representative was chosen from each of the three major R&D performing sectors: government, industry, and higher education. Team members are prominent members of their respective research communities and have a broad range of S&T expertise.

Study Objectives and Scope

The terms of reference for the study (see Annex I) provides that the study program should lead to recommendations on:

- areas of S&T cooperation for initial focus under the bilateral S&T cooperation agreement;
- modalities of cooperation with the greatest potential to stimulate new or enhanced research within and between the academic, industry and government sectors; and
- specific activities and mechanisms to implement the bilateral S&T agreement between the two countries and, more generally, to foster greater and more effective S&T cooperation.

Approach

The Expert Team drew on the rich body of reports and deliberations on Canadian and Chinese national S&T capacities and performance.[2] The Expert Team also considered it essential to engage with, listen to, and learn from, those involved in China-Canada S&T cooperation, Canada-China business interactions, and Canadian and Chinese scientific research “at the frontier”. For this reason, the Expert Team:

- held more than 33 face-to-face meetings with individual researchers and research teams with experience in Canada-China S&T partnerships, and more broadly with international research cooperation;

- organized 16 round-table discussions with leaders from within the Canadian and Chinese research and business communities to hear first-hand of their experiences and challenges in undertaking collaborative S&T activities; and

- conducted 11 site visits to research institutes and establishments within both countries that exemplified their respective S&T strengths and capabilities.

The Expert Team members visited the cities of Guangzhou, Shanghai and Beijing in April of 2006 and the cities of Vancouver, Calgary, Ottawa, and Toronto in June of 2006. There was strong regional representation and participation in the consultation events held within these cities.

Organization of this report

The report's first section reviews three pillars for Canada-China S&T complementarity: economic environment and challenges; S&T capacity and performance; and the longstanding cultural and institutional ties between the two countries. The report's second section identifies four priority areas for Canada-China S&T cooperation, while its third section identifies potential modalities and mechanisms for Canada-China S&T cooperation. The final section of the report summarizes implementation challenges and the Expert Team's main recommendations.

1.0 Three pillars for Canada-China S&T cooperation

Pillar I: Economic complementarities

Canada is an open economy with a well developed transportation, communications, and S&T infrastructure,[3] abundant natural resources, and innovative firms serving domestic and global markets. The marketplace framework laws and institutions are well developed. Relative to the U.S., a high proportion of Canada's employment and output is accounted for by SMEs. The workforce is highly educated, as Canada has one of the highest rates of post-secondary education within the Organization of Economic Cooperation and Development (OECD). As well, Canada's research based universities are among the very best in the world.

The OECD reported in June of 2006, that the Canadian economy has continued to deliver excellent results in nearly all respects. Output and employment growth have been robust, while the unemployment rate has fallen to its lowest level since 1974. Inflation remains comfortably under control, and the general government and current account balances are in surplus. Canadians enjoy one of the highest living standards in the OECD. However, the OECD also noted that improving productivity growth remains a key challenge for Canada.[4]

International S&T cooperation, including with the People's Republic of China, is an important means for Canada to address the productivity challenge. It will help effectively connect Canada to international flows of knowledge, people, and global markets, facilitate Canadian business participation in global supply chains, and increase Canada's attractiveness for productivity-enhancing capital investment.

China has undergone a dramatic economic transformation during the past few decades. It is rapidly moving from being a strong low-cost manufacturing economy to being an innovative knowledge-based economy. The average annual growth rate was 9.7% per year between 1979 and 2004 and the economy grew 9.9 per cent in 2005. China has increasingly placed more emphasis on education, graduating 4 million college students in 2005. The S&T research capacity continues to be developed beyond such major centres as Beijing, Shanghai, and Guangzhou. According to the OECD, in 2006, for the first time China will spend more on R&D than Japan, and so becomes the world's second highest investor in R&D after the U.S.[5]

In January of 2006, the President of the People's Republic of China, Hu Jintao addressed the Fourth National Science and Technology Conference in Beijing and stated that an important challenge for China was to build an innovation-oriented country. He said that China will embark on a new path of innovation with Chinese characteristics, including: adhering to innovation, seeking leapfrog development in key areas; making breakthroughs in key technologies and common technologies to meet urgent requirements in realizing sustained and coordinated economic and social development; and making arrangements for frontier technologies and basic research with a long-term perspective. [6] International S&T cooperation, including with Canada, is one means for China to address the innovation challenge.

The Expert Team considers the following as being important economic areas of Canada-China complementarity from the perspective of deriving greater benefits through enhanced S&T cooperation between the two countries:

- both countries share a common priority in increasing the standard of living and quality of life of their citizens through encouraging S&T and its application within their respective economies.

- both countries consider investments in education and training to be a critical driver of S&T performance and, in turn, improved productivity. A highly educated workforce is the new "natural resource" for growing the knowledge and innovation based economies of both countries.

- China is expanding its own physical infrastructure to meet the demands of its economic transformation and growth. Canada has world class expertise and advanced technologies for designing and developing physical infrastructure (including within the transportation, energy, communications, and environmental sectors).

- Canada seeks to expand and diversify its global markets for exports of goods and services (including environmental, education, health and financial services) and participate more strongly in global supply chains. China joined the World Trade Organization in 2001 and today is the 3rd largest trading nation in the world. Between 1995 and 2005, China's total imports of goods and services increased at an annual average rate of 16% and its exports of goods and services increased at an average annual rate of 19%.[7] China is Canada's 2nd largest source of imported goods, with imports of $29.5 billion in 2005. China ranks 4th as a destination for Canadian exports ($7.1 billion in 2005).[8] Canada ranks as China's 14th largest export market and 18th for imports.

Pillar II: S&T Capacity and Performance Complementarities

The Expert Team reviewed many indicators of Canadian and Chinese S&T capacities and performance. While each indicator has its own strengths and limitations,[9] in general they reinforce the Expert Team's findings on Canada-China economic complementarities. For example:

- China's Gross Expenditures on Research and Development (GERD) as a percentage of its GDP[10] has been steadily increasing over recent years (reaching 1.23% in 2004), reflecting in part China's commitment to increasing China's R&D capabilities and building a more innovative nation to address the country's economic and social needs. Canada too has

placed emphasis on improving innovation performance, including through research and development (R&D). Canada's GERD/GDP ratio reached almost 2% in 2004. In Canada, public investments in R&D have focussed on the higher education sector. Here, the challenge and opportunity is the translation of basic research into goods and services for the domestic and global marketplaces.

- Both countries are increasingly "knowledge intensive economies" as reflected in the increasing number of persons engaged in S&T activities. Both Canada and China are within the top 10 countries in the world ranked by scientific publication output. In 2005, China had over 810,000 research personnal. China's education sector is undergoing a large-scale expansion. In 2004, new entrants of Master's degree and post-master's programs in China reached 326,000 and the number of graduates of Master's degree and post-master's programs reached 111,000. By field of study, the natural sciences and engineering have the largest share of new entrants, increasing strongly in the period 1995-2004.[11] Canada (with a far smaller population than China) had over 112,000 research personnnel in 2005. Canada had more than 806,000 full-time university students in 2005, an increase of nearly 150,000 over the last four years. Between 1999 and 2005, Canadian university enrolment in the physical and life sciences increased by 21.6%.[12]

Canada can benefit from the expanding R&D base in China, including that performed within the non-governmental sector (an important consideration in relation to strengthening Canadian participation in global supply chains). China can benefit from improved access to leading edge research conducted within Canada.

Pillar III: Cultural and Institutional Ties

Canada and China have forged strong cultural and institutional ties over many years that form a critical third pillar for a strong Canada-China S&T relationship.

China is Canada's number one source of immigrants, with 33,248 landings in 2002 (about 14 per cent of all immigrants to Canada in 2002). A high percentage

of Chinese immigrants over recent decades are skilled workers, including in those disciplines that underpin S&T activities and whose qualifications are in high demand.[13] The flow of people and their skills and knowledge also runs from Canada to China. There are upwards of 200,000 Canadians living in China. In 2004-2005 half of the foreign students studying in Canada were from Asia, and China accounted for 46% of these Asian students.[14] As well, an estimated 900 Canadian students are studying in China.

The strong cultural and institutional links between Canada and China are forged by people to people interactions. The medical services provided by Dr. Norman Bethune in China in the twentieth century remain a prominent symbol of the Canada-China friendship. But the wide range and strength of Canada-China cultural linkages is also symbolized by the thousands of individual Canadian and Chinese citizens making a difference today to the lives of people in both countries and the world. For example:

- The Terry Fox Run, named in honour of Canadian amputee runner Terry Fox who, at age 21, attempted to run across Canada to raise money for cancer research, is no longer just a Canadian tradition. The Terry Fox Runs are now also held in China and are amongst the biggest in the world, attracting, on average, over 10,000 participants each year;

- The new Director General of the World Health Organization is Dr. Margaret Chan, formerly Director of Health in Hong Kong, who obtained her Medical Degree from the University of Western Ontario in Canada;

- Dashan (Mark Rowswell), born in Canada, has been called the most famous foreigner in China. He has become a regular fixture on Chinese television, a cultural icon across the nation, and has received numerous awards for his promotion of strong Canada-China relations.

Both Canada and China have well developed national and regional institutional structures for public governance (including policy development and funding) of S&T. Both countries consider S&T activities within their non-governmental sector as essential parts of their national S&T systems and that the "demand" side of S&T (market pull) is as important as building the "supply" side capacity for S&T.

Universities in Canada have been actively collaborating with their counterparts in China for decades. The Association of Universities and Colleges of Canada (AUCC) reports that over 266 agreements have been signed with China including in agriculture, computer sciences, health, education, and engineering. Canadian and Chinese governments (at both central and sub-central levels) have entered into a large number of bilateral MOUs directly or indirectly to encourage S&T cooperation. The Expert Team believes that, during the initial implementation phase of the Canada-China S&T Cooperation Agreement, a full inventory of the government-to-government MOUs (beginning at the central government level) should be undertaken to ascertain their current status, operation and results.

2.0 Priority areas for strengthening Canada-China S&T cooperation

The Expert Team's selection of priority areas was informed by extensive consultations (together with the publicly available analyses of respective Canadian and Chinese S&T strengths and capacity[15]) with leading representatives from Canadian and Chinese businesses, institutions of higher education, as well as central and sub-central levels of government.

Overview of the scope of Expert Team Consultations in Canada and China

In Guangzhou, site visits included two ICT manufacturing companies and a science park (incubator) developed by the local government. Roundtables focussed on S&T activities within the areas of ICT, environment, health, and energy.

In Shanghai, site visits were made at two universities: Tongji and Jiao Tong. A presentation was given by the Science and Technology Commission of Shanghai Municipality. Many potential S&T collaborative opportunities were raised, including within the areas of energy, environment, health, agriculture, and life sciences.

In Beijing, roundtable discussions focussed on collaborative opportunities in the energy, environment, health, agriculture, ocean technology, and biotechnology sectors. Visits to Tsinghua University and the China Petroleum University were undertaken, covering fuel cell bus demonstrations and energy research projects.

In Vancouver, site visits were made to a world leading Canadian company developing proton exchange membrane fuel cells, as well at the National Research Council's Institute for Fuel Cell Innovation (NRC-IFCI). Roundtables included presentations and discussion around energy (fuel cells), biotechnology/health (cancer research), and environment (coastal management, and bioproducts/biomass).

In Calgary, site visits were made to the University of Calgary's Energy Labs and to TRLabs/NEWT. Roundtables were held covering oil and gas, petroleum, unconventional gas, oil sands, and ICT sectors in Alberta.

In Ottawa, the teams met with representatives from the post-secondary research community. A site visit was made to the National Research Council's Institute for Chemical Processing and Environmental Technology (NRC-ICPET). The Ottawa Roundtable included representatives from Montreal's life sciences and aerospace sectors and centred on: environment, agriculture, biotechnology/health, and aerospace.

In Toronto, a site visit was made to a leading Canadian company in the field of biomaterials and regenerative medicine. The Expert Team also visited the Medical and Related Sciences (MaRS) Discovery District. The team was introduced to the activities of the Government of Ontario's Centres of Excellence. Biotechnology and ICT roundtables were held and included presentations by researchers from the University of Toronto as well as the Canadian Institutes of Health Research (CIHR).

The Expert Team also took into account that the Canada-China S&T cooperation Agreement is between the two national governments and that the priority areas under the agreement should hold:

- significant social and economic benefit for the citizenry of both countries, as well as the broader global community;
- demonstrable opportunity for S&T cooperation, particularly in pre-competitive research areas where governments can play an important role in promoting and enabling S&T; and
- scope for S&T cooperation across the three major S&T performing sectors (business, higher education, and government).

It is the Expert Team's judgement that, for the purposes of implementing the Canada-China S&T Cooperation Agreement, four areas meet these criteria:

- Energy
- Environment
- Health & Life Sciences / Biotechnology
- Agricultural Foods and Bioproducts

The Expert Team finds that S&T cooperation in the energy and environment areas should be "Tier 1" priorities for attention under the Canada-China S&T Cooperation Agreement. In general, the size of the mutual social and economic benefits to be derived from increased Canada-China S&T cooperation are – *at least in the short term* – greater within the areas of energy and the environment. This judgement is based on: the S&T capacities of the two countries; the existing baseline of cooperative S&T activities; and the degree and nature of economic complementarities. An additional reason is that, while there are widely recognized linkages and synergies between S&T activities across all four areas, they are particularly prominent between the energy and environmental areas.

The Tier 2 areas, health and life sciences/biotechnology, and agricultural foods and bioproducts, are no less important areas where Canada-China S&T cooperation can yield important social and economic benefits for both countries. However, some (although not necessarily all) of these opportunities are longer term in nature (i.e. in the bioproducts area and even within some life science sub-areas). In some cases, the baseline of existing government-to government S&T cooperative activities is well established (i.e. in agricultural foods). In other cases, (i.e. bioproducts and biofuels) the "market pull" for S&T is growing but is not as relatively strong yet as that found within the energy and environment areas.

The Expert Team strongly believes that the recommended focus on these four priority areas does not, and should not, preclude from future consideration other areas for potential Canada-China S&T cooperation.

Information and Communication Technologies (ICTs)

Information and Communications Technologies (ICTs) are a key enabler for progress in S&T across all sectors of economic activity within all economies, largely because ICTs are general purpose and transformative technologies.

The Expert Team concluded that the pace of technological development and application within ICTs, together with the well-established global infrastructure for further ICT development, suggests that a new emphasis on Canada-China S&T cooperative focus with respect to ICTs is not required at this time. At the same time, both countries will benefit through the application of ICTs in support of the S&T activities undertaken within each of the four priority areas.

2.1 Canada-China S&T Cooperation in Energy

There are significant social and economic benefits for both Canada and China, and the broader global community, to be derived from greater S&T cooperation in the area of energy. Energy is a global concern, as energy availability is crucial to the economic growth and social development of all countries as well as to the stability of regions. International cooperation in developing and applying new energy technologies is one means to effectively address energy supply challenges (e.g. conventional energy deposits are finite and are increasingly found within higher cost and environmentally sensitive locations) and the impacts of burning fossil fuels on the environment. Greater international cooperation in S&T in energy can maximize the use of scarce resources through avoiding duplication of effort. Shared investments in basic energy S&T research can help reduce costs through economies of scale and diversification of risk.

China needs energy to fuel its rapidly expanding economy and industrialization. Energy is required for rapid growth in transportation, industrial, residential and other uses, but China has limited types of energy deposits to exploit. Although China's coal reserves are abundant, other conventional energy resources (including oil and gas) are less plentiful.

Canada is a resource rich nation and a net energy exporter, with large reserves of all types of energy resources including: conventional oil and gas, coal, oil sands, coal bed methane, gas hydrates, uranium, and hydro. Canada also conducts world class research into new and renewable energy (e.g. hydrogen, fuel cells, biofuels, wind, water, solar, geothermal). Canada is the third largest producer (second largest exporter) of natural gas, and the ninth largest producer of crude oil in the world. Canada has developed world-class technology and

know-how in many energy sectors, including fuel cells and hydrogen, and is willing to work with other countries in providing integrated solutions to help address the energy challenges they face.

Opportunities for Canada-China S&T cooperation in energy

During its consultations in Canada and China, the Expert Team's attention was drawn to many examples of existing S&T cooperation in energy and opportunities for enhancing cooperation.

Fuel Cells

In Beijing, the Expert Team was given an in-depth introduction to fuel cell research at Tsinghua University, which has primary responsibility for the development of fuel cell buses in China. Existing cooperation between Canada and China in fuel cells includes the development of fuel cell buses and related infrastructure for the 2008 Beijing Olympics. In support of this project, Tsinghua University has been cooperating with: Canada's National Research Council's Institute for Fuel Cell Innovation (NRC-IFCI); the University of British Columbia; Ballard Power Systems; Westport Innovation; Greenlight Power Technologies in Vancouver; Dynetec Incorporated in Calgary; and with Hydrogenics Corporation in Toronto.

In Canada, the Expert Team heard presentations from Ballard Power Systems and the National Research Council's Institute for Fuel Cell Innovation (NRC-IFCI). Great interest and enthusiasm was shown by researchers in Canada for increased research cooperation between the two countries. Ballard's presentation focussed on their research progress, commercialization focus,

roadmap and targets, and current connections with China. Presentations from the National Research Council's Industrial Research Assistance Program (NRC-IRAP) covered key challenges for Canadian SMEs in enhancing their participation in S&T cooperation with China.

Oil and Gas

There are many existing cooperative Canada-China S&T activities in the oil and gas sector. For example, in Beijing, the Expert Team was introduced to the work of the State Key Laboratory for Heavy Oil Processing at the China University of Petroleum. The laboratory collaborates with Canada through Canadian firms and both Canadian federal and provincial governments (National Research Council and Alberta Energy). Work is undertaken through analytical laboratories, a computational modeling centre, bench scale experimental systems, and continuous demonstration pilot projects.

In Calgary, the Expert Team was introduced to the extensive oil and gas research at the University of Calgary's Schurlich School of Engineering and opportunities for cooperation with China in such areas as: air injection-based improved oil recovery (IOR); computational thermodynamics; gas hydrates; reservoir simulation technologies; steam assisted gravity drainage (SAGD), and vapour extraction (VAPEX).

Traditional energy interests are well matched between the two countries as China needs more diesel which is a major oil sands bitumen product. Many potential areas for increased cooperation were drawn to the attention of the Expert Team, including coal gasification, coal bed methane extraction technologies, advanced technologies for the production of gas hydrates, and renewable energy

technologies (wind, geothermal, bioenergy, fuel cells, hydrogen generation and usage, integrating renewables into existing energy systems, flexible energy grids and algorithms).

The Expert Team finds that these and other opportunities for enhanced S&T cooperation are also examples of the wide scope for Canada-China S&T cooperation across the three major S&T performing sectors of business, higher education, and government.

The Expert Team notes that numerous MOUs are already in place between the two countries at the central and sub-central governmental levels. For example, Canada's Department of Natural Resources has in place several geo-science MOUs with its counterpart government ministries from the PRC. In 2004, the Government of Alberta signed an MOU with China's Ministry of Science and Technology to encourage scientific and technological cooperation and research exchange. This has led to joint research laboratory projects between the University of Alberta and the PRC's Ministry of Science and Technology including in energy and the environment.

In summary, the Expert Team concludes that Canadian and Chinese interests in the energy sector are well aligned and the two countries have complementary strengths and resources. China has had an ambitious technology R&D strategy in this field since the 1980s. Its national goals are supported by government laboratories and state enterprises. Canada has world class facilities and a lengthy history of hands-on commercial experience, while China also has world class facilities, and a critical mass of expertise.

2.2 Canada-China S&T Cooperation for the Environment

There are significant social and economic benefits for both Canada and China, and the broader global community, to be derived from greater S&T cooperation in the area of the environment. Sustaining a healthy environment is the responsibility of all countries as actions of any one country have impacts far beyond its borders. Canada and China, each with large surface areas and long coast lines, share a mutual interest in sustaining their natural environments. For these reasons, scientific cooperation in order to protect the environment is a natural fit for both countries.

Opportunities for Canada-China S&T cooperation for the environment

In Vancouver, the Expert Panel was introduced to the North-east Pacific Time-series Undersea Network Experiments (NEPTUNE) project. This project involves building the world's largest cable-linked seafloor observatory. The observatory will enable scientists to observe and interact with the complex earth and ocean processes that occur on, above and below the seafloor. Research done here can be applied to many global environmental problems and opportunities, such as: earlier warning of earthquakes and tsunamis; more accurate estimates of commercial fish stocks; improved models for climate prediction; potential new energy sources; and water pollution control.

In Ottawa, a number of presentations to the Expert Panel focussed on potential areas to further develop Canada-China S&T cooperation such as: environmental impacts of off-shore oil and gas activities (water discharge, marine noise, and oil spills); and controlling and reducing air pollution, including through particle emissions monitoring and atmospheric modeling.

In Shanghai, at both Tongji and Jiao Tong Universities, many different departments are working on environmental problems with the potential for cooperation with Canada. These areas encompass: water conservation and management including: drinking water treatment and distribution; water pollution control and wastewater treatment; solid waste treatment and disposal; as well as environmental assessment; and city planning /sustainable urbanization.

In Beijing, the Chinese State Ocean Administration, the State Environmental Protection Agency, and the Chinese State Forestry Administration, discussed cooperation possibilities with Canada in such areas as: coastal management, environmental protection and disaster mitigation; fisheries and aquaculture; polar sciences; and forest management and protection, including the control of invasive species as well as forest fire detection and control.

2.3 Canada-China S&T Cooperation in Health and the Life Sciences

With the advent of increased international travel, the spread of communicable diseases can occur much faster than in the past. Recent public health emergencies, such as SARS and the spread of avian influenza, are just two illustrations of the global nature of health issues and highlight the need for international cooperation to prevent or contain outbreaks of epidemics. In addition, both Canada and China face health issues related to the consequences of demographic developments, including aging populations.

The Expert Team notes and commends the increased level of Canada-China government-to-government cooperation in the field of public health in response to global disease threats (i.e. SARS, Avian influenza).

Opportunities for Canada-China S&T cooperation in health and life sciences

There are many opportunities for Canada-China S&T cooperation for the mutual health benefit of both countries and the global community. Some of these opportunities build on each country's investments in basic research in the life sciences, including biotechnology. There are opportunities for helping citizens maintain and improve their health through sharing knowledge for the development of new therapeutic products, including in pharmacogenomics. Other opportunities are found in the clinical practices and health circumstances of both countries. Canada-China S&T cooperation could capitalize on China's strong base in epidemiology and Canada's strengths in genomic/proteomics.

Shanghai's Jiao Tong University has a wide range of research strengths and has identified opportunities for exploring cooperation with Canadian health research institutes in such areas as: neuropsychiatric and human genetics; microbiology and microbial metabolic engineering; biomedical equipment; bio-heat and mass transfer.

Traditional Chinese Medicine (TCM) is another area in which the two countries may want to examine possibilities for cooperation. In Beijing, proposals were advanced for cooperation between Canada and China in TCM, including the application of western scientific methodology and techniques to the study of TCM. The Beijing Municipal Science and Technology Commission also proposed cooperation in the research and training of clinical pyschogeriatics and other health issues relating to aging populations.

In Guangzhou, the team was introduced to partnerships between the Guangzhou Institute of Biomedicine and Health partners with McGill University in a clinical

study centre and with the Ottawa Health Research Institute in research stem cell and regeneration medicine and research.

In Vancouver, the team was introduced to the work of cancer researchers at the BC Cancer Agency and at the University of British Columbia and included discussions on how cooperation with China could be increased. Researchers are working on many developments in cancer technology, including functional imaging (as being one cutting edge technology of the future) and xenografts. Challenges remain on how to translate this work into practical applications in the health care system. Examples of successful Canada-China cooperation included a project on cervical cancer screening in China, conducted by the BC Cancer Agency, and Landing-Motic Medical Services Company Ltd.

In Ottawa, representatives from the CIHR Institute of Neurosciences, the NRC-Institute for Institute for Biological Sciences (NRC-IBS), and Health Canada each discussed research done in their respective organizations as well as cooperation efforts and intentions with China. One potential area of opportunity mentioned, as it was in Beijing, was enhanced cooperation in natural health products and TCM. Another area explored was how the two countries can work together on the issue of aging and palliative care/end of life strategies to fill potential gaps in nursing care and finding creative ways to provide health care for aging populations – an issue which is becoming more critical in both Canada and China.
In Toronto, Rimon Therapeutics introduced the Expert Team to advanced medical polymers that have biological healing and restorative properties. Researchers from the University of Toronto and the Canadian Institutes of Health Research discussed their work on pain research as well as their own personal experiences in successful cooperation between Canada and China. Their presentations underlined the benefits of encouraging student exchanges as key

to making Canada and China known and attractive to future researchers. Other strengths and complementarities identified included Canada's strengths in clinical research. China's large population makes it an important location to capture proteomic and genetic data.

2.4 Canada-China S&T Cooperation in Agricultural Foods and BioProducts[16]

All governments share a common interest in ensuring that their populations have a safe and secure supply of food and that production is sustainable. The joint social benefits of international S&T cooperation in this area have long been recognized by Canada and China.

S&T co-operation between Canada and China in agriculture and food is well established and there are numerous government-to-government MOUs in place. For example, The Government of Canada's Department of Agriculture and Agrifood has in place an MOU with the Ministry of Science and Technology of the People's Republic of China concerning dairy science and technology cooperation as well as another with the PRC's Ministry of Education respecting scientific collaboration and personal training in agriculture. The agricultural ministries of the two countries are involved in more than 30 on-going research projects, the third highest level of projects underway between China and other countries (after the USA and France). The Expert Team's attention was also drawn to a new China-Canada educational exchange program in the agricultural area shortly to be implemented. This program includes scientific internships for 2nd year PhD Chinese students (a target of 20 students per year).

Opportunities for Canada-China S&T cooperation in agriculture and food, and bioproducts

In Guangzhou, the Guangzhou Branch of the Chinese Academy of Sciences outlined their eight main research fields which include sustainable development and agricultural zone pattern and application technology. In Beijing, a review of programmes from the Chinese Academy of Agricultural Sciences highlighted co-operation with Canada over the past 20 years and the opportunity to build on this foundation in such areas as: nutrient management for sustainable agriculture; climate change; and micro-hydropower systems.

In Shanghai, Jiao Tong University has a School of Agriculture and Biology, which undertakes research in a number of key areas and is engaged on a number of collaborative research projects with their counterparts in Canada (e.g. one cooperative project with Simon Fraser University in British Columbia is focused on biological controls for vegetable disease).

BioProducts

In addition to the mutual advantages of S&T cooperation in “traditional” areas of agriculture and food, Canada and China stand to benefit from exploring greater cooperation in related new areas, particularly agricultural waste and other biomass. Technologically advanced production within these two areas can provide potential feedstock for the production of bioproducts, including biofuels (e.g. ethanol, bio-diesel, bio-gas). This area of research is newer and Canada-China research cooperation in this field is generally not as well established as in more traditional areas of agricultural research.

The Guangzhou Branch of the Chinese Academy of Sciences discussed a cooperative project they have with the University of Western Ontario in thermal biomass. The objective of the project is to establish mathematical models of fluidized bed gasifiers for biomass gasification.

In Canada, the Expert Team was introduced to the $300 M (CDN) bioproducts industry in British Columbia. Current target areas of research and development include: biocontrols & remediation; biomass crops; bioenergy; biofuels; biomaterials; and biochemicals. It was highlighted to the Expert Team that transportation fuels is a particularly fast growing sector with two main technologies that can generate biofuels compatible with modern fuel infrastructure. The Canadian forestry industry is particularly interested in research in biofuels due to the large amount of waste wood products caused by the Mountain Pine beetle infestation. The State Forestry Administration in China may also have interests in cooperation with Canada on this issue as they may also have waste wood products from infestations of the Asian Longhorned beetle.

3.0 Modalities and mechanisms for Canada-China S&T cooperation

The Expert Team's deliberations on modalities (defining the roadmap for promoting S&T cooperation) and mechanisms (the specific means to get where the two countries wish to go) were guided by the following considerations:

- initial cooperative and collaborative Canada-China S&T activities within the priority areas should focus on projects involving basic and pre-competitive research. Two to three years is the recommended maximum length of time for initial projects in order to obtain early indicators of successful cooperation and what adjustments may be necessary. Lessons learned and best practices from initial cooperation can then be applied to future projects and modes of cooperation can be modified as required;

- the role of the Canadian and Chinese governments should be as promoters of S&T cooperation in the priority areas;

- the type and level of cooperation should reflect the level of cooperation in existence today within each priority sector;

- the two governments should have clear criteria for measuring progress within each of the priority area. The two governments should set a clear target (i.e. 2-3 years) for assessing what has been achieved beyond the current baseline of cooperative activities; and

- attention should be given to encouraging the full participation of SMEs in Canada-China S&T cooperation within the priority areas. The role of governments should be as a promoter and enabler of full SME participation in Canada-China cooperative S&T activities.

These considerations, taken together with the results of the Expert Team's consultations in Canada and China, led the team to identify four major modalities for implementation of the Canada-China S&T Cooperation Agreement: building linkages and partnerships; supporting the development of young researchers; supporting SME participation in S&T opportunities; and supporting joint S&T infrastructure.

3.1 Building Linkages and Partnerships

The Expert Team recommends that the two governments should seek to build "platforms" for cooperation. These may be different for each sector, depending on the level of cooperation that already exists between Canadian and Chinese researchers in that sector. For example, relationships between Canadian and Chinese agricultural research institutions are longstanding and well established.

The "platforms" that the two governments may wish to set up may include: to deepen existing relationships by providing additional resources to projects

identified as national priorities and of mutual benefit; or to broaden the relationship into related fields in which cooperation is less mature, such as in the use of agricultural wastes to produce biofuels. For areas such as bioproducts, where research links are less well established, attention could focus on helping establish more linkages through such mechanisms as: symposiums; conferences; and other forums where scientists from both countries could gather to discuss ideas for partnerships, including the application of S&T network concepts.

One S&T Network Model: Canada's Networks of Centres of Excellence

Networks of researchers are becoming a predominant form of S&T cooperation and cooperation throughout the world. Within Canada, the research network model has found concrete form within the Government of Canada's Networks of Centres of Excellence (NCE) program.

NCEs are partnerships among universities, industry, government and not-for-profit organizations. Their objective is to turn Canadian research and entrepreneurial talent into economic and social benefits.

The networks are nation-wide, multidisciplinary and multisectoral research partnerships which aim to connect research with industrial know-how and strategic investment.

3.2 Supporting the development of young researchers

Support and development for young researchers is one mode of cooperation recommended by the Expert Team. Mechanisms for cooperation include young scientist exchange programmes at the post doctorate or junior professor/junior research scientist level to help build understanding, friendships and linkages between the Canadian and Chinese research community.

There are many examples of this working to the advantage of Canada and China

where researchers currently have research labs in both countries. Other suggested exchanges include with graduate students and senior undergraduate students. This would give potential researchers early exposure to potential partnerships and research opportunities in each other's countries. There are currently successful personnel and student exchanges that new programmes can be modelled on. For example, there are several innovative student exchange programmes between China and the U.S. as well as China and Australia.[17]

3.3 Engaging the participation of SMEs

The Expert Team finds that attention should be given to increasing the participation of SMEs in Canada-China S&T cooperative activities. Large companies are, in general, fully capable of sourcing R&D from where it best suits their needs. SMEs may not have sufficient resources or information to do this on their own. The support offered for SME's through the National Research Council's Industrial Research Assistance Program (NRC-IRAP) stands as one model that might be drawn upon to open up greater opportunities for SME participation in Canada-China S&T activities.

3.4 Joint Infrastructure

The Expert Team believes there are opportunities to collaborate in joint Canada-China S&T infrastructure. Joint laboratories for research (either actual or virtual) were often proposed during roundtables discussions. Examples of potential areas where joint laboratories could be set up includes in coastal monitoring, aquaculture, and water remediation.

The Expert Team notes that there are already strong examples of S&T joint-

infrastructure development. In June of 2005, A new laboratory facility (the Shanghai-Toronto Institute for Health Research) was opened in Shanghai as a joint initiative of the University Health Network (University Health Network is Canada's largest hospital, and a major teaching hospital of the University of Toronto), and the Institute for Health Science, part of the Chinese Academy of Sciences. The new institute is located on the campus of the Institute for Health Science and the Shanghai Jiao Tong University School of Medicine. It features a state-of-the-art laboratory for identifying disease biomarkers as well as chemistry laboratories for analyzing potential new drugs. The institute's Toronto counterpart is a new laboratory in the Toronto Medical Discovery Tower.[18]

A second recent example of S&T joint-infrastructure development is the January 2006 announcement of new funding for a Joint Research Laboratory Project between the University of Alberta and MOST. The laboratory project will permit joint research projects to be undertaken, with a focus on three main areas of research: nanotechnology, environment and energy. Projects will be identified, and agreed to, based on their importance and interest to both Alberta and China. The first five joint research projects have been approved and scientists from both sides have already begun working together.[19]

4.0 Concluding observations and summary of recommendations

The Expert Team was impressed by the existing level of scientific cooperation and collaboration already occurring between researchers in Canada and China and by the respect shown by researchers in the two countries for the scientific and technological capacity and performance of both countries. There is now an opportunity for the two countries to build on this strong foundation to derive new

social and economic benefits for both countries and the world at large.

The Expert Team observes that the implementation of the Canada-China S&T Cooperation Agreement will not be without challenge. For example:

- intellectual property considerations will need to be addressed in a forthright manner. The development of common templates or the sharing of best practices in IP management stands as one potentially valuable approach for addressing IP considerations arising from joint collaborative research;
- it will be important to ensure that the existing baseline of S&T cooperative activities between the two countries is adequately documented and recognized in developing new initiatives. On this matter, the Expert Team recommends that existing range of S&T collaborations between Canada and China be catalogued in order to give the Canada-China S&T Cooperation Agreement's implementing committee an idea of what the existing collaboration base is that they are building on; and
- the two governments should develop clear criteria for measuring progress under the Agreement. The two governments should set a target (e.g., 2-3 years) for assessing what has been achieved beyond the current baseline of cooperative activities.

In summary, through this report, the Expert Team makes the following specific recommendations:

1. That two tiers embracing four areas should be the initial focus under the Canada-China S&T Cooperation Agreement:
    - Tier 1: Environment and Energy
    - Tier 2: Health & Life Sciences / Biotechnology and Agricultural Foods & Bioproducts

2. That the modalities for S&T co-operation should include:
    - Building linkages and partnerships
    - Supporting the development of young researchers
    - Engaging SMEs
    - Joint infrastructure - including virtual and actual laboratories.

ANNEX I

CANADA-CHINA S&T COMPLEMENTARITY STUDY

Terms of Reference

The Governments of Canada and China, recognizing the mutual benefits to be gained from enhanced cooperation in science and technology (S&T), have entered into negotiations for a bilateral agreement for cooperation in S&T. The Agreement will provide a framework for enhanced S&T cooperation, including suggesting some possible modalities of cooperation and noting that priority areas for activity under the agreement are to be identified in writing by the two countries. In addition, the Agreement will include an Annex addressing the issue of intellectual property rights within the context of activity under the Agreement.

The governments of Canada and China, in order to inform the process of defining priority areas for enhanced S&T cooperation under the Agreement, and to more generally promote and encourage Canada-China S&T cooperation between the two countries, have commissioned a Joint Study on Enhanced Cooperation in the Field of Science and Technology between Canada and China (the Canada-China S&T Complementarity Study). The primary objectives of the Study will be to:

- recommend areas of S&T cooperation for initial focus under the bilateral S&T cooperation agreement;
- recommend modalities of cooperation with the greatest potential to stimulate new or enhanced research cooperation between researchers and research organizations from the academic, industry and government sectors;
- recommend specific activities and mechanisms to implement the bilateral S&T agreement between the two countries and, more generally, to foster greater and more effective S&T cooperation; and
- provide other recommendations as may be deemed appropriate by the Study Team.

Structure and Operation:

The Study Team will comprise three members from each country, with two being designated as Team Leaders. It is expected that the three Study Team members from each country will bring to the Study a broad range of S&T experience and expertise.

The Managing Agencies for the Study will be Industry Canada for Canada and the Ministry of Science and Technology for China. The Managing Agencies will provide a secretary, or secretaries, to support the Study Team, and will fund all the costs of the Study within the limits defined at the outset. The Co-Leaders will submit a draft report to the Managing Agencies within five months of commencement of the Study, with a final report due within six months.

In order to accomplish the Study objectives, the Study Team may utilize face-to-face meetings, round-table discussions in each country, site visits, internet and web-based dialogue and consultation, and/or other means as appropriate as approved by the Managing Agencies. It is envisaged that the national components of the Study Team will visit their counterparts and participate jointly in some of the Study elements such as the roundtables and site visits.

ANNEX II

ACRONYMS

CAAMS	Chinese Academy of Agricultural Mechanization Sciences
CIHR	Canadian Institutes of Health Research
GDP	Gross Domestic Product
GERD	Gross Expenditures on Research and Development
HCNG	Hydrogen Natural Gas Blends (HCNG powered vehicles offer the potential for reduction in nitrogen oxides (NOx) emissions).
ICT	Information and Communications Technology
MaRS	MaRS is a not-for-profit corporation founded by leaders from the business and public sectors to improve commercial outcomes fron science and technology innovations.
MOST	Ministry of Science and Technology, Government of the People's Republic of China
MOU	Memorandum of Understanding
NCE	Networks of Centres of Excellence
NEPTUNE	North-east Pacific Time-series Undersea Network Experiments
NRC	National Research Council of Canada
NRC-ICPET	National Research Council of Canada's Institute for Chemical Processing and Environmental Technology
NRC-IRAP	National Research Council of Canada's Industrial Research Assistance Program
NRC-IFCI	National Research Council of Canada's Institute for Fuel Cell Innovation
OCE	Ontario Centres of Excellence
OECD	Organisation for Economic Cooperation and Development
PRC	People's Republic of China
R&D	Research and Development
S&T	Science and Technology
SAGD	Steam Assisted Gravity Drainage
SMEs	Small and Medium-Sized Enterprises
TCM	Traditional Chinese Medicines
VAPEX	Vapour Extraction

ANNEX III

Expert Team Member Biographies

Government Representative (Canada): Dr. Richard Normandin

Dr. Normandin is the National Research Council's Vice-President, Physical Sciences. Appointed in May 2003, his current portfolio includes seven NRC research institutes on Astrophysics, Chemical Process and Environmental Technology, Microstructural Sciences, Information Technology, National Measurement Standards, Molecular Sciences and Nanotechnology.

He is also responsible for the Fuel Cell & Hydrogen Program and he recently established an NRC Sustainable Technology Initiative. As part of his portfolio, Dr. Normandin will be leading discussions on issues of national importance including the development of NRC strategies on nanotechnology, astrophysics and measurement standards.

Dr. Normandin joined the NRC in 1981 and became the Director General of the NRC Institute for Microstructural Sciences (NRC-IMS) in 1998. At NRC-IMS he spearheaded the Solid State Optoelectronics Consortium, was Group Leader of the Optoelectronics Devices Group and Director, Component Technologies.

He received a B.Sc. and M.Sc. from the Université de Montréal and a Ph.D. from the University of Toronto in 1980. He was the recipient of a Rutherford Memorial Scholarship from the Royal Society of Canada, which supported his post-doc studies at Stanford University.

He has published over 170 papers in the field of optoelectronics and holds over 25 patents. In 1995, he was elected a 'Fellow' of the Optical Society of America for distinguished service and technological contributions to optoelectronics and nonlinear optics. He also received the "Commemorative Medal for the 125th Anniversary of Confederation" from the Governor General of Canada and an "Outstanding Achievement Award" from NRC. In 2000, the Canadian Association of Physicists (CAP) and the National Optics Institute (INO) awarded Dr. Normandin the CAP-INO Medal for Outstanding Achievement in Applied Photonics.

Industry Representative (Canada): Dr. John S. MacDonald

Dr. MacDonald was born on August 13, 1936 in Prince Rupert, British Columbia, Canada. He received his early education in the British Columbia school system, entering the University of British Columbia in 1954. After graduating with honours in Electrical Engineering in 1959, he enrolled in the Graduate School of Electrical Engineering at the Massachusetts Institute of Technology, where he earned a Master's Degree in 1961 and a Ph.D. in 1964. While at M.I.T., Dr. MacDonald was extensively involved in teaching at both the undergraduate and graduate levels, winning the C.E. Tucker Teaching Award in 1962 and a Ford Postdoctoral Teaching Fellowship in 1964. He was appointed an Assistant Professor of Electrical Engineering at M.I.T. in 1964, and one year later assumed a similar position at the University of British Columbia, becoming an Associate Professor in 1969.

He is one of the founders of MacDonald, Dettwiler and Associates Ltd. and served as President and Chief Executive Officer until September 1982, and as Chairman from 1982 until his retirement from the company in 1998. MacDonald Dettwiler, which started in Dr. MacDonald's basement in Vancouver, has become the largest space company in Canada with annual sales exceeding 750,000,000 CAD.

After a few years of "retirement", Dr. MacDonald co-founded Day4 Energy Inc. in 2001. Day4 is a solar energy company dedicated to commercializing a new technology that has the potential to make solar energy cost competitive with fossil fuel as a means of generating electrical energy. He is currently the Chairman and CEO of Day4 Energy.

Dr. MacDonald's technical interests lie in the areas of photovoltaic energy systems, advanced digital systems engineering, remote sensing and information processing. He led the design team for the first LANDSAT ground processing system produced by MacDonald Dettwiler and was involved in the early development of synthetic aperture radar processing at that company. Later, Dr. MacDonald's technical activities concentrated in the areas of information extraction from advanced sensor systems and the use of integrated data sets as a means of increasing our ability to extract useful information from spaceborne Earth observation data. At the present time, his technical activity is concentrated on the development of cost-competitive solar power systems.

He has also been active in an advisory capacity to governments. From 1993 to 1995 he served as Canada's member of the Eminent Persons Group of Asia Pacific Economic Cooperation (APEC), which was charged with providing a vision for the future of APEC. He served as one of three Canadian members of the APEC Business Advisory Council (ABAC) from 1998 to 2003, the Advisory Council to the Canadian Space Agency (2001-2004) and is currently serving on the Canadian Defence Science Advisory Board. Highlights from the past include serving as a member of the Science Council of Canada, the National Research Council of Canada, the British Columbia Premier's Advisory Council on Science and Technology, the National Advisory Board on Science and Technology and the Science Council of British Columbia. He was also a member of the Sectoral Advisory Group on International Trade (Automotive and Aerospace Sector) during the Free Trade negotiations with the U.S. He led the industrial team that successfully stimulated the formation of the Canadian Space Agency in 1989. He has also served on a number of advisory committees and boards of the U.S. government in the field of Earth observation from space. In the industrial sector, Dr. MacDonald has consulted for a number of organizations in the areas of technology, technology assessment and management. Over the years he has served on the board of directors of more than ten companies, and is currently a director of Analytical Spectral Devices Inc. of Boulder, Colorado and the British Columbia Discovery Fund Inc. of Vancouver, B.C., as well as Day4 Energy Inc. Dr. MacDonald is a registered Professional Engineer, a Fellow of the Institute of Electrical and Electronic Engineers (I.E.E.E.), a Founding Fellow of the Canadian Academy of Engineering and a Fellow of the Canadian Aeronautics and Space Institute. He is a member of the American Society of Photogrammetry and Remote Sensing, the International Neural Network Society and

the Royal Astronomical Society of Canada. In 1984 he was awarded the I.E.E.E. Centennial Medal, the Gold Medal of the Canadian Remote Sensing Society in 1989 and in 2000 was the first recipient of The John H. Chapman Excellence Award of the Canadian Space Agency, the Agency's highest award. He has been awarded eight honorary doctorates from universities across Canada, and was the Honorary Colonel of 407 Maritime Patrol Squadron of the Canadian Armed Forces from 1992 to 1998 during which time he flew on most of the types of mission that the squadron is responsible for. He was named an Officer of the Order of Canada in 1988, and in 1999 he was named one of "100 Top British Columbians of the 20th Century" and one of the "50 most influential British Columbia Business leaders of the 20th Century".
Dr. MacDonald is married to Alfredette and they have two adult sons and three grandchildren.

Higher Education Representative (Canada): Dr. Laurie H.M. Chan

Professor Laurie Hing Man Chan holds a Professorship, a BC Leadership Chair, as well as a NSERC Northern Research Chair in the Community Health Program at the University of Northern British Columbia.

He is an expert in environmental toxicology; nutritional and food toxicology; functional food; nutrition and the environment of indigenous peoples; risk assessment of contaminant exposure; analytical chemistry; food security and effects of climate change. The main focus of his research is to address the concerns of the elevated levels of contaminants, including PCBs, DDT, toxaphene, and mercury, in the traditional foods of Indigenous Peoples, particularly in northern communities.

Dr. Chan received a B.Sc., and M.Phil from Hong Kong University and a Ph.D. from the University of London in 1990. He did his postdoctoral work at the University of Western Ontario.

He is a fellow of the Linnean Society of London, has served as a councillor for the Society of Toxicology of Canada (of which he is currently a member), and also has membership in the Society of Toxicology, the Society of Environmental Toxicology and Chemistry and the American Society for Nutritional Sciences.

He has also been active in an advisory capacity to governments, having served as a member of expert and review panels/teams for Health Canada, the US Environmental Protection Agency, the National Institute of Child Health and the Human Development Global Network. He has also served on various advisory bodies for the Canadian Council for Ministers of Environment, 18 Aboriginal communities and organizations, CIHR, Niqiit Avatittinni (Food in the Environment) Committee in Nunavut, NSERC, International Union of Nutritional Sciences. He is on the Editorial Board of the journals, Science of the Total Environment and Asian Journal of Ecotoxicology. As well, Dr. Chan is a founding member of the International Network For Circumpolar Health Research.

Dr. Chan has published 92 papers in various academic journals and 4 book chapters. He has also had over 100 oral and poster presentations co-authored with students in the last 4 years.

Since 1993, he has supervised or co-supervised 26 Master's and 8 Doctoral students, and 6 Postdoctoral Fellows, 26 undergraduate student projects, 8 laboratory assistants, 6 project coordinators and 2 data analysts.

He has also co-founded two companies: KCLM Research in Nutrition Inc. and Medibarics Inc.

Dr. Chan lives in Prince George with his wife Winnie.

Government Representative (China): Mr. Ma Linying

Mr. Ma Linying was born on March 27, 1955 in Heibei Province, China. He is now Deputy Director General of Department of International Cooperation, Ministry of Science and Technology (MOST).

In 1982, Mr. Ma started working in Foreign Affairs Bureau, State Science and Technology Commission (SSTC). Later he was appointed as Senior Staff Member, Division of Asian and African Affairs of Department of International Cooperation (DIC), SSTC; Deputy Consul, S&T Group of Chinese Consulate General in Los Angeles, USA; Principal Staff Member, Division of American and Oceanian Affairs of DIC, SSTC; Deputy Director, Division of American and Oceanian Affairs of DIC, SSTC; Counselor, Science and Technology Division of Chinese Embassy in Israel; Director, Division of American and Oceanian Affairs of DIC, MOST; and Counselor for Science and Technology Consul of Chinese Consulate General in Houston, USA.

Industry Representative (China): Dr. Li Shujun

Dr. Li Shujun was born on July 23,1962 in Heilongjiang Province, P. R. China. He is the Vice President of Chinese Academy of Agricultural Mechanization Sciences (CAAMS), Vice President and Secretary-General of Chinese Society of Agricultural Machinery (CSAM). He is the President of China Packaging and Food Machinery Industry Association, the Executive Vice President & Secretary General of Food Processing Engineering Institution, CMES.

Dr. Li is very active in the international arena in agricultural engineering and food processing fields. In 2003, he was elected Vice Chair of the Six Section of International Commission of Agricultural Engineering (CIGR) and continues to hold that position today. He is also the Executive Board Member of CIGR, the Country Delegate of International Association for Engineering and Food, and is a member of the Club of Bologna.

In 1978, he was enrolled in Jiamusi Agricultural Machinery College, where he majored in agricultural machinery design and manufacturing and received his Bachelor degree. He entered Jilin University of Technology in 1983, majored in food processing engineering and got his Master Degree in 1986. After that, he started his research work at the Chinese Academy of Agricultural Mechanization Sciences (CAAMS) and eventually became the department's director. Realized the necessity for further study, he returned to university for his doctor program in 1996 in China Agricultural University and focused on food science. In 1998, he received his Doctor Degree. During this period of time, he was involved in and was in charge of several regional and national scientific research projects, such as Researching and manufacturing GWG Series Belt Dryer (1996.1—1997.12), Researching and manufacturing Corn Trans-planting Machine (1996.10—1998.12), French Fries Production Line Engineering for Shanxi Jiashun Food Co., Ltd.(1997), Feasibility Study Report on Producing 1200 tons French Fries in Dingxi , Gansu Province of China (Aug. 1998), researching and manufacturing ZCD-500 Vacuum Nitrogen Filling Packaging Machine (Oct.1998).

Dr. Li has been engaged in sciences and technology research work for over 25 years in the fields of agricultural machinery and agricultural products processing machinery. In 1996, he became a Senior Engineer and was in charge of the work of Science and Technology Dept. of CAAMS. In 1998, he was appointed as the Assistant President of CAAMS and two year later, he became the vice president of CAAMS.

Dr. Li has achieved many scientific results and the majority of them have been transferred to industry. He is one of the Chinese experts of the Joint Working Group of agricultural science and technology co-operation between Ministry of Science and Technology, China (MOST) and The Department of Agriculture of the United States of America (USDA) and responsible for agricultural products processing.

Higher Education Representative (China): Professor Lun Jingguang

Professor Lun Jingguang was born on January 29,1933. He is currently Deputy President, Electric Vehicle Institute of Chinese Electro technology Society, and National Project Coordinator GEF-UNDP-MOST Cooperation Project Demonstration for Fuel Cell Bus Commercialization in China.

He worked for Tsinghua University since July 1953 until retired at the professor level in Dec.1998. Since then he has been engaged to work on electric, hybrid and fuel cell vehicles.

He was National Project Coordinator, “Studies on Key Technologies of Electric Vehicles” Project of Former State Planning Commission from 1992 to 1998.

He was also Director, Automobile Handling and stability sub-committee of Society of Automotive Engineer-China from 1980 to 1985.

ANNEX IV

List of Organizations and Individuals Consulted

Guangzhou Roundtables, China

Mr. Ma Xianmin, Deputy Director General, **Department of Science and Technology of Guangdong Province**
Dr. Hou Hongming, Guangzhou Branch, **Chinese Academy of Sciences**
Dr. Deng Feiqi, Vice Director and Professor, Scientific Research Division, **South China University of Technology**
Mr. Xia Qifeng, Director, **Department of Science and Technology of Guangdong Province**
Mr. Lu Qikai, Vice Director, **Guangzhou Electric Apparatus Research Institute**
Mr. Chen Baorong, Director, **Guangzhou Municipal Science and Technology Bureau**
Ms. Liu Mei, **Sun Yat-sen University**
Mr. Tan Jianjun, General Manager, **Guangzhou CASample Information Technology Co. Ltd.**
Dr. Weishan Li, Professor of Chemistry, **South China Normal University**
Dr. Mu Dehai, China National Analytical Center, **Guangdong Institute of Analysis**
Ms. Lan (Joy) Zhao, Project Engineer, **Novatec Consultants Inc.** (Vancouver, Canada)
Dr. Zeng Lu, Deputy Director, **Department of Science and Technology of Guangdong Province**

Guangzhou Site Visits, China

Guangdong Software Science Park, Postcom, and GZ Hui Si Communication Technology Co, Ltd.

Shanghai Roundtables, China

Professor Jin, Tuo, School of Pharmacy, **Shanghai Jiao Tong University**
Mr. Li Yan, Assistant Director, International Exchange & Cooperation Office, **Tongji University**
Dr. Bin He, Vice Director of the Office of Science Research, **Tongji University**
Professor Li Yongsheng, Vice President, **Tongji University**
Ms. Song Yang, Program Officer, **International Cooperation Science & Technology Commission of Shanghai Municipality**
Mr. Hai-feng Liu, Deputy Director, Division of International Cooperation, **Science & Technology Commission of Shanghai Municipality**
Professor Ming Xinguo, Henry, Assistant Director, Computer Integrated Manufacturing (CIM) Institute, School of Mechanical and Power Engineering, **Shanghai Jiao Tong University**
Professor Kang Sun, Deputy Director, Institute of Composite Materials, Deputy Director, State Key Lab of Metal Matrix Composites, **Shanghai Jiao Tong University**

Professor Siqing Xia, **Vice Dean, College of Environmental Science and Engineering, Tongji University**

Shanghai Site Visits, China

Shanghai Jiao Tong University and Tongji University

Beijing Roundtables, China

Professor Kang Kejun, Vice President, **Tsinghua University**
Mr. Meng Qingyun, Manager, Engineering Department, Beijing SinoHytec Co., Ltd., **Tsinghua University**
Dr. Junzhi Zhang, Associate Professor, State Key Laboratory of Automotive Safety and Energy, Department of Automotive Engineering, **Tsinghua University**
Dr. Wang Hewu, Associate Professor, State Key Laboratory of Automotive Safety and Energy, **Tsinghua University**
Professor Chunming Xu, Vice President of Academic, Director, State Key Laboratory of Heavy Oil Processing Deputy Director, Centre for Heavy Oil Technologies, **China University of Petroleum**
Professor Ouyang Minggao, Director of National Laboratory of Automotive Safety and Energy, **Tsinghua University**
Mr. George Wu, General Manager, Beijing SinoHytec Co., Ltd., **Tsinghua University**
Professor Jianqiang Zou, Director, Health and Biotech Division, Department of Social Development S&T, **Ministry of Science and Technology**
Mr. Cao Jie, Deputy Director, Division of American & Oceania Affairs, Bureau of International Cooperation, **Chinese Academy of Sciences**
Mr. Chen Sihong, Deputy Director, International Cooperation Division, **Beijing Municipal Science & Technology Commission**
Mr. Liu Xiuping, Program Manager Division of American, Oceania and East European Programs, Bureau of International Cooperation, **National Natural Science Foundation of China**
Mr. Wei Yan, Programme Officer, Department of International Cooperation, **State Oceanic Administration**
Mr. He Guangsen, Deputy Director, The Division of International Cooperation, **The Chinese Academy of Forestry**
Mr. Quan Shi, Deputy Director, State Key Laboratory of Heavy Oil Processing, **China University of Petroleum**
Professor Suoqi Zhao, State Key Laboratory of Heavy Oil Processing, **China University of Petroleum**
Mr. Wu Gen, Division of Scientific Infrastructure Construction, Department of Basic Research, **Ministry of Science and Technology**
Mr. Fanhua Ma, Associate Professor, State Key Laboratory of Automotive Safety and Energy, **Tsinghua University**
Mr. LiHong Zhang, Head of International Affairs Sections, Secretary-General of SmiRT-18, Institute of Nuclear and New Energy Technology, **Tsinghua University**
Mr. Liu Yuanwen, Director, Division of Americas and Oceania, Department of International Cooperation, **Ministry of Science and Technology**

ANNEX IV

Beijing Site Visits, China

Tsinghua University and State Key Laboratory of Heavy Oil Processing, China Petroleum University

Vancouver Roundtables, Canada

Mr. John Swaan, Chair, **BC BioProducts**
Dr. Yoga V. Yogendran, Director, Technology Deployment and Commercialization, **NRC Institute for Fuel Cell Innovation**
Dr. Victor Ling, Vice President, Discovery, **BC Cancer Agency**
Dr. Tim L. Walzak, President and CEO, Innovation and Development Corporation, UVIC Technology Transfer, **University of Victoria**
Dr. Sam Abraham, Director, Technology Development Office, **BC Cancer Agency**
Mr. Mike Rosenberg, Director of Corporate Development and Strategy, **Ballard Power Systems**

Vancouver Roundtables, Canada (continued from previous page)

Mr. Michael J. Brown, Chairman, **Chrysalix Energy Venture Capital**
Mr. Glenn Rousseau, Executive Director, **BC BioProducts Association**
Mr. Christopher Ryan, Executive Director (Acting) – Pacific Industrial Research Assistance Program, **National Research Council Canada**
Mr. Ben Chow, Business Development Manager, **Ballard Power Systems**
Dr. Andy Spencer, Director, Science Infrastructure & Planning, **Malaspina University College** (Nanaimo)
Ms. Qing Yu, Manager, Asia Office, Industrial Research Assistance Program, **National Research Council**
Mr. Duncan Dow, Vice Chairman, **BC BioProducts Association**
Mr. Michael Dujardin, Controller, **Hydrogen and Fuel Cells Canada**
Mr. Brian Beck, Director of Operations, Canada/China Hydrogen and Fuel Cell Coalition, **Fuel Cells Canada**
Mr. François Girard, Business Development Officer, Institute for Fuel Cell Innovation, **National Research Council Canada**
Ms. Maja Veljkovic, Institute for Fuel Cell Innovation, **National Research Council Canada**

Vancouver Site Visits, Canada

Ballard Power Systems and the National Research Council's Institute for Fuel Cell Innovation

ANNEX IV

Calgary Roundtables, Canada

Dr. Duane Sniezek, Chief Executive Officer, **Network for Emerging Wireless Technologies, TR Labs** (Edmonton)
Dr. Mike Raymont, Chief Executive Officer, **EnergyINet Inc.**
Mr. Michael Gatens, Chairman, **Quicksilver Resources Canada**
Dr. Michael Leung, Vice President Development, **TR Labs**
Mr. Matt Ursenbach, Research Engineer, Department of Chemical and Petroleum Engineering, Calgary Centre for Innovative Technology (CCIT), SCHULICH School of Engineering, **University of Calgary**
Mr. Mark Hawkins, Manager, Technology Sector Development, **Calgary Technologies Inc.**
Mr. Jian Li, Graduate Studies, SCHULICH School of Engineering, **University of Calgary**
Mr. Charles Reichert, Executive Director, **WiTec Alberta**
Ms. Joan Morgan, Office of International Relations, International Centre, **University of Calgary**
Mr. Rollie Dykstra Director, Communications, Wireless & Geomatics, ICT Industries Branch, Innovation and Science, Innovation Implementation, **Government of Alberta** (Edmonton)

Calgary Site Visits, Canada

University of Calgary Centre for Innovative Technology, University of Calgary and TRLabs

Ottawa Roundtables, Canada

Dr. Jim Tunney, Competency Leader, Organic Materials, **National Research Council Canada**
Mr. George Michaliszyn, Director, Life Sciences Branch, **Industry Canada**
Mr. Stuart Salter, Associate Director General, **Natural Resources Canada**
Mr. Denis Leclerc, Manager, Policy and International Relations, Executive Vice-President's Office, **Natural Sciences and Engineering Research Council of Canada**
Mr. Brian E. Colton, Senior Policy Analyst, Departmental Biotechnology Office, **Health Canada**
Ms. Winnie Pang, Advisor - Asia Region, International Health Policy & Communications Division, **Health Canada**
Dr. Xiu Qing Li, Research Scientist of Molecular Genetics, Potato Research Centre - Fredericton, New Brunswick, **Agriculture and Agri-Food Canada**
Dr. Rémi Quirion, **Douglas Hospital** (Montreal, Quebec)
Dr. Bertrand Jodoin, Professor, Department of Mechanical Engineering Office, **University of Ottawa**
Dr. Jonathan Beddoes, Department of Mechanical and Aerospace Engineering, **Carleton University**

Ottawa Roundtables, Canada (continued from previous page)

Dr. Ken Lee, Research Scientist, Fisheries and Oceans Canada, Centre of Offshore Oil and Gas Environmental Research, **Bedford Institute of Oceanography**, (Dartmouth, Nova Scotia)
Dr. Peter J. Nicholson, President, **Council of Canadian Academies**
Ms. Karen McBride, Vice President, International Affairs Branch, **Association of Universities and Colleges of Canada**
Ms. Lauren Small, Senior Manager, International Relations (Asia, Middle East), **Canadian Space Agency** (Saint Hubert, Quebec)
Mr. Robert R. Hastings, Director, Gas Turbine Laboratory, **National Research Council Canada**
Dr. Danica B. Stanimirovic, Director, Neurobiology Program, **National Research Council Canada**
Dr. Jianqiang Zhou, Chief Officer of Scientific Relations, China, International Science Cooperation Bureau, **Agriculture and Agri-Food Canada**
Mr. Kevin A. Jonasson, Director, Commercialization, **National Research Council Canada**
Mr. Christian Sylvain, Director of Policy and Planning Policy, Planning and International Affairs, **Social Sciences and Humanities Research Council of Canada**
Dr. Nigel Lloyd, Executive Vice President, **Natural Sciences and Engineering Research Council of Canada**
Ms. Leila Ronkainen, Senior Communications Advisor, Canadian Forest Service, **Natural Resources Canada**
Mr. Bruce Currie-Alder, Senior Policy Analyst, Policy and Planning Group, **International Development Research Centre**

Ottawa Site Visits, Canada

National Research Council's Institute of Chemical Processing and Environmental Technologies (ICPET)

Toronto Roundtables, Canada

Dr. David Schindler, Executive Director, **BioDiscovery Toronto**
Dr. Michael May, President and CEO, **Rimon Therapeutics Ltd.**
Dr. William Lu, Director of Professional Services, **Platform Computing**
Dr. Peter Liu, Scientific Director, **Canadian Institutes of Health Research, Institute of Circulatory and Respiratory Health** (Vancouver)
Dr. Min Zhuo, Canada Research Chair in Pain and Cognition, EJLB-CIHR Michael Smith Chair in Neuroscience and Mental Health, **Department of Physiology, University of Toronto**
Ms. Veronika Litinski, Director, Business Resource Centre, **MaRS Discovery District**
Mr. David Fransen, Executive Director, **Institute for Quantum Computing, University of Waterloo**
Mr. Mark Romoff, President and CEO, **Ontario Centres of Excellence Inc.**
Mr. Colin Fidler, Sales Operations Program Manager, **Platform Computing**

ANNEX IV

Toronto Site Visits, Canada

Rimon Therapeutics Ltd., Ontario Centres of Excellence Inc., and the MaRS Discovery District

END NOTES

[1] "Joint Declaration in Science and Technology Cooperation between the Government of Canada and the Government of the People's Republic of China" (Ottawa: September 2005). Accessed at: http://www.infoexport.gc.ca/science/china_jointdeclaration-en.htm

[2] "The State of Science & Technology in Canada", National Academies of Science (Ottawa: 2006) accessed at: http://www.scienceadvice.ca/documents/Complete%20Report.pdf. See also**:** **"**Premier calls for building innovation-oriented nation" Ministry of Science and Technology, Government of the People's Republic of China. Accessed at: http://www.most.gov.cn/eng/photonews/200601/t20060112_27803.htm

[3] In October 2006, the Prime Minister of Canada announced federal contributions totalling $591 million for over a dozen Pacific Gateway port infrastructure projects.

[4] "Economic Survey of Canada 2006: Managing the challenges ahead" OECD (Paris: 2006). Accessed at: http://www.oecd.org/document/29/0,2340,en_33873108_33873277_36953117_1_1_1_1,00.html

[5] "China will become world's second highest investor in R&D by end of 2006, finds OECD." OECD (Paris: 2006). Accessed at: http://www.oecd.org/document/26/0,2340,en_2649_34273_37770522_1_1_1_1,00.html

[6] President Hu Jintao "President Hu outlines tasks for building innovation-oriented country". Address to Fourth National Science and Technology Conference on January 9 2006. Accessed at: http://english.gov.cn/2006-01/09/content_151696.htm

[7] China Trade Profile 2005, World Trade Organization. Accessed at: http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=CN

[8] Statistics Canada The Daily, November 9 2006. Accessed at: http://www.statcan.ca/Daily/English/061109/d061109a.htm

[9] There are many indicators of S&T capacity and performance that were drawn to the attention of the Expert Team during the course of their deliberations. However, the Expert Team finds that comparable indicators remain "a work in

progress." In this regard, the Expert Team takes special note of, and strongly commends, the current work on S&T indicators being undertaken by the Government of China's Ministry of Science and Technology (MOST) in close cooperation with the OECD through the OECD-China National Innovation System Project.

[10] According to the OECD's Frascati Manual, Gross Expenditures on Research and Development represents: "total intramural expenditure on research and development performed on the national territory during a given period". When researchers make cross-country comparisons, it is common for them to look at a country's spending on R&D as a proportion of the country's Gross Domestic Product (GDP), otherwise known as a country's "GERD/GDP ratio", in order to see how well countries perform in relation to each other.

[11] S&T Indicators in China: An Evolving National Innovation System in a Globalising Economy." OECD Background Paper DSTI/STP(2006)32 (Paris: 2006).

[12] Statistics Canada, The Daily, November 7, 2006. Accessed at: http://www.statcan.ca/Daily/English/061107/d061107a.htm

[13] "Canada-China Relations", Canadian Embassy in Beijing. Accessed at: http://www.beijing.gc.ca/beijing/en/navmain/canada/596/index.htm

[14] Statistics Canada, The Daily, November 7, 2006. Accessed at: http://www.statcan.ca/Daily/English/061107/d061107a.htm

[15] The Expert Team had before it a number of different studies and report on Canadian and Chinese S&T capacities and capabilities when considering priority areas for Canada-China S&T cooperation. As well, the sectors identified by the Expert Team are strongly supported by studies such as the 2006 Council of Canadian Academies' (CCA) report on *The State of Science & Technology in Canada (*published after the Expert Team concluded its deliberations). This work also found that many Canadian S&T strengths are found within energy, environmental, agricultural and agrifood, and life science areas.

[16] Bioproducts are sustainable, environmentally friendly novel products or applications generated from renewable bioresources based on technologically advanced eco-efficient conversion processes. Examples of bioproducts include: bio-lubricants; bio-rust inhibitors; bio-cleaning chemicals; bio-plastics; bio-fibres for insulation; and many other products with applications in automotive industry, aircraft manufacturing, electronics, and furniture industries.

[17] The PRC's programme with the U.S. is called *Summer Institutes* and involves 150 U.S. postdoctoral fellows and PhD students participating in field trips across China for two months. Funding support was provided by the U.S. National Science Foundation and was coordinated by the MOST China S&T Exchange Center. The participants attended orientation sessions for one week and then were dispatched on field trip across China for the remaining period of time. Another model is the Australia-China programme (commenced in 2006) with eight postdoctoral fellows and PhD students from China invited by Australia to examine the energy, environment, and mining sectors. Australia will send their participants to China during 2007.

[18] "New Drug Laboratory a China-Toronto Collaboration". News Release, University Health Network, November 9, 2005. Accessed at: http://www.uhnresearch.ca/news/php/readarticle.php?id=786

[19] "Alberta-China research lab receives $500,000 boost". News Release, University of Alberta, January 23, 2006. Accessed at: http://www.engineering.ualberta.ca/news.cfm?story=42349