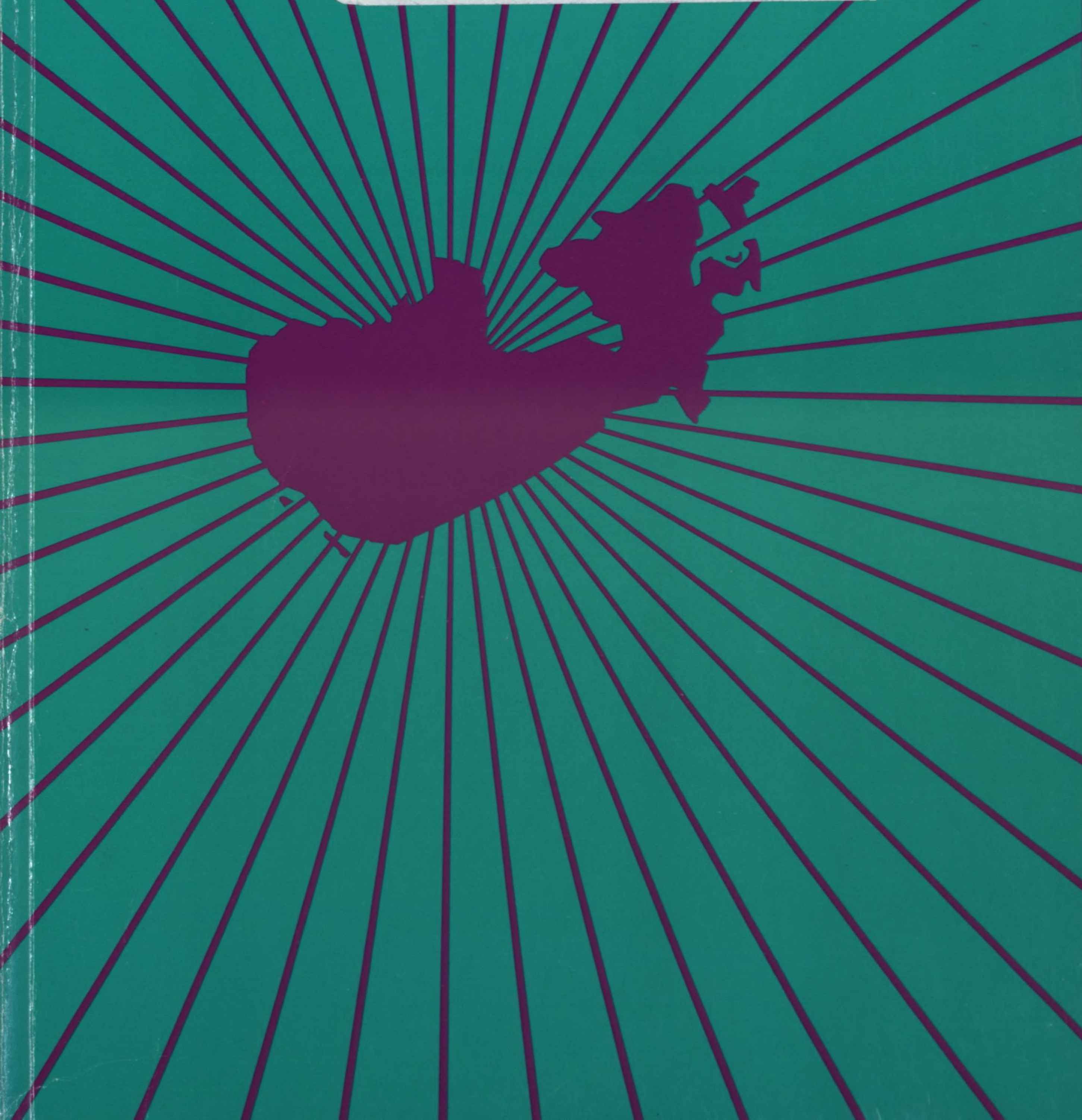
[TE]CHNOLOGY PROSPECTING ABROAD

A GUIDE TO TECHNOLOGY OPPORTUNITIES IN SELECTED COUNTRIES



Canada

External Affairs and
International Trade Canada

TECHNOLOGY PROSPECTING ABROAD

A GUIDE TO TECHNOLOGY OPPORTUNITIES IN SELECTED COUNTRIES

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1.0 INTRODUCTION

Technology is the practical knowledge that is used to develop the products, processes and services that keep firms internationally competitive. In an increasingly technology-intensive global economy, knowing what the technology development environment is abroad and how to gain access to technology in other countries is imperative. ● ●

The purpose of this document is to describe, in succinct fashion, the technological trends and research programs in selected countries. The reader should note that this document is merely a snapshot of science and technology (S&T) activities in these countries, and provides a guide to some of the more visible activities.

These countries are serviced by the Science and Technology Counsellor and Technology Development Officer Network of External Affairs and International Trade Canada. The Science and Technology Counsellors, in seven posts abroad, monitor scientific and technological developments and respond to requests from Canadian organizations about technological opportunities. The Counsellors, in conjunction with Technology Development Officers, and Trade Commissioners facilitate technology acquisition and technology transfer, and familiarize Canadian firms with the business practices and operation of science and technology organizations in foreign countries.

This document is designed with the needs of Canada's small and medium sized business sectors in mind.

This initiative is undertaken to facilitate international technology transfer and research cooperation between Canadian firms and technology development organizations and their counterparts abroad.

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2.0 NORTH AMERICA

2.1 UNITED STATES OF AMERICA (NATIONAL OVERVIEW)

The United States, with a Gross Domestic Product (GDP) of over US$4 trillion, is the largest and most diversified economy in the world. It spends about 2.8 percent of its GDP on research and development (R&D); the government and industry finance about equal shares (48 percent) of R&D, but industry actually performs about 70 percent of the R&D. When defence R&D is deleted, the United States spends about 1.8 percent of GDP on R&D. ● ●

The United States has about 66 R&D scientists and engineers per 10,000 population, equal to Japan and far ahead of other industrial countries. In industry, R&D is geographically widespread. American post-secondary education in terms of production of research and graduates is second to none in terms of quality. The United States does however face an increasing shortage of scientists and engineers making it a potentially large "sink" for highly qualified personnel trained elsewhere.

TECHNOLOGY TRENDS

The United States does not have an explicit industrial or technology policy. The United States federal government views its role in S&T as having two primary goals: (1) to support basic research, including academic research, where there is no economic motivation for industry to undertake the work on its own; (2) to fund R&D for national security purposes (the definition of national security is increasingly being broadened). Officially, all other civilian R&D is best determined and financed by the private sector.

The United States is active in all areas of R&D, and continues to lead the world in most sectors but one notable area of weakness is the consumer electronics industry where the United States companies have been unable to compete successfully with other countries, especially Japan, even though it can lay claim to most of the basic innovations in the industry.

TECHNOLOGY STRENGTHS

The United States leads or is competitive in virtually all areas of technology. It has clear leadership in space and aerospace and related fields. Many of the most innovative companies in biotechnology, pharmaceuticals and medicine are American. It continues to lead in basic computer technology especially in development and production of central processing units (CPUs) and specialized chips and clearly leads in computer software.

Many of the areas of United States strength are led by industry but there is often a large direct or indirect assistance from government programs such as the Department of Defence, the United States Space Program, the research work conducted or funded by the National Institutes of Health or the National Laboratories of the Department of Energy.

In the future, these and other new big science projects such as the Space Station, the Human Genome Project, the Global Change Research Program, and the Clean Coal Technology demonstration program can be expected to have important commercial spin-offs.

KEY ORGANIZATIONS

The United States federal government with a budget of some US$1.2 trillion is a huge force in the development of technology. This has been especially true in computers, communications and information processing technologies. Some of the key organizations influencing technology development in the United States federal government are:

The Department of Defence (DOD): DOD, with an annual budget in the order of US$300 billion, has and will continue to have a major influence on many areas of technology development with an emphasis on information technologies, advanced industrial materials and transportation R&D (air, land, and water). Canadian companies by virtue of the Defence Development/Defence Production sharing arrangements enjoy special access to many DOD procurements. One agency of special note is the Defence Advanced Research Projects Agency (DARPA) which is DOD's primary funder of advanced R&D and is the only agency in DOD whose mandate is to maintain United States' technological superiority without having to tie its work directly to a particular defence mission or project.

National Aeronautics and Space Administration (NASA): NASA, with an annual budget of US$10-12 billion, is the largest funder and procurer of advanced technologies in the civilian side of the United States government. With major programs in space science, space transportation, manned space flight, remote sensing and communications satellites, it funds work in virtually all areas of R&D.

Department of Energy: The Department of Energy also has a large and diversified procurement of advanced technology goods and services, while access to its nuclear weapons programs will remain relatively closed to non-American companies. The massive clean-up of its weapons plants may provide opportunities to Canadian companies with expertise in nuclear/environmental technologies. New and renewable energy research is being revived under President Bush after being virtually eliminated during the Reagan administration. Almost every other agency of the United States federal government procures high tech goods under contract, many of which are open to Canadian companies by virtue of the Free Trade Agreement (FTA) and the General Agreement on Tariffs and Trade (GATT).

KEY SUPPORT PROGRAMS

The United States federal government has relatively few direct industrial support programs. The major influence is the massive size of the federal procurement for virtually the complete range of advanced technology goods and services. However, many states now have industrial/technology development support programs, most of which are directed at supporting or attracting local industry.

Every federal government department is required to operate a Small Business Innovation Research program (SBIR). This program is directed at United States resident companies, often start-up companies or older companies trying to diversify.

The United States federal government has in place a 20 percent R&D tax credit. Until now this credit has been subject to a two year or shorter life cycle. President Bush has proposed making the credit permanent and expanding the criteria for eligible expenses.

CONDITIONS OF ACCESS

United States officials make wide use of "Buy America" clauses in either authorizing programs or in appropriating funds. Canadian owned companies are exempt from many of these provisions as they apply to civilian government agencies by virtue of GATT and the FTA. Procurements below $25,000 are subject to Buy America and not covered by the FTA. There are also provisions for preferential treatment of small business and minority owned firms, which are only available to American firms.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

As in other areas, the United States is both the largest potential market for Canadian technology goods and services and our largest source of technology. The special defence relationship and our own export control laws, which mirror United States export control laws, give us special access to United States technologies which may be difficult or impossible for industry in other countries to acquire.

The United States market is a highly competitive one. Price and quality will ultimately determine success or failure in the consumer market.

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2.1.1 Atlanta (Southeast United States)

The Southeastern United States has approximately 20 percent of the United States population (43 million). The Southeast transacts over 11 percent of United States-Canada trade by dollar volume and accounts for approximately 17 percent of the United States GDP. Seven major technology concentrations exist in the following cities:

- Tampa/Orlando/Miami - 6 million population
- Atlanta/Georgia - 3.8 million population
- Charlotte/Greenville/Spartanburg - 2.2 million population
- Raleigh/Durham/Greensboro - 1.6 million population
- Knoxville/Nashville - 1.5 million population
- Huntsville/Birmingham - 1.5 million population
- Mississippi - 0.8 million population

On a scientist per capita basis Huntsville, Alabama ranks number one in the United States; Raleigh/Durham, North Carolina is number six and Atlanta, Georgia is number eight. Major manufacturing sectors are: aerospace/military; furniture; forest products; automotive/transportation; communication/telecommunication; textile/apparel/carpet; printing; plastics; and poultry.

The Southeastern United States has several universities with technology development of national and international stature: eg. Georgia Tech, Emory University, University of Alabama, North Carolina State University and the University of Miami.

TECHNOLOGY TRENDS

The area's principal specialities and directions are:

- Biotechnology: Strength in genetic mapping, immunology coordinated through the Center for Disease Control, universities and several R&D centers.

- Environment: Federal money has been earmarked for the Sunbelt Institute along with several universities and companies for R&D in atmosphere, ground water and waste control.
- Space: Three NASA centers (Alabama, Florida, and Mississippi) have over 64 percent of NASA's US$12 billion budget.
- Marine: Five major R&D centers on the east and gulf coasts have Federal project funding.
- Military: Defence R&D budget in the territory reached over US$400 million in 1986.
- Engineering: Atlanta is nationwide hub for consultants (1400), because of excellent transportation (air) network out of Atlanta, and because of Georgia Tech as the number one engineering R&D university in the United States.
- Transportation: Excellent systems and several of the latest United States rapid rail systems, along with good ship, rail, truck and highway provide the model intermodal systems. Atlanta, for example, has an automated intermodal center for rapid interchange, rail to truck.
- Advanced Materials: The area is a major source of ceramic raw material in the United States; four major R&D centers comprise the hub for advanced materials development.
- Production Manufacturing Process: Several projects are in play to apply developed technologies to actual manufacturing processes.

TECHNOLOGY STRENGTHS

Areas of strength include:

- Aerospace: The largest employer in several Southeastern States, with a large number of surrounding smaller spin-off companies.
- Poultry: The industry in Georgia has increased production by 200 percent while reducing the work force by over 60 percent the past several years (all with automation).
- Textile/Apparel/Carpet: The Southeast manufactures over 50 percent of the country's finished products.
- Furniture/Woodwork: The first (North Carolina) and second (Mississippi) largest concentrations of furniture manufacturing in the Southeast which lead in wood product automation technologies.
- Pulp/Paper/Forest: The leading American paper institute just relocated to Georgia Tech in Atlanta (where the international trade show is held every other year).
- Communications: The leading area in the manufacturing of telecommunication and satellite machinery and equipment.
- Energy/Power: The area has the two major American nuclear research centers (Oakridge, Tennessee and Savannah River Project, South Carolina) and five major power companies.
- Agriculture/Food: The area has five major universities developing research along with three large research centers for initiating research (for example poultry processing).

KEY ORGANIZATIONS

These include:

- Universities: Georgia University System, University Alabama Huntsville, Duke, Clemson University, Mississippi University and Tennessee University. Each has full programs of industry projects that relate to state needs.
- Technology Transfer Conference Inc.: This company organizes six technology shows a year to link industry, government and university for technology transfer.
- Lloyd Patterson International Inc.: this company, which integrates all industries for technology transfer, is also linked to the Florida NASA.

- Advanced Technology Development Center: a twenty year old incubator with an excellent record of graduating companies to the commercial world.
- Huntsville Association of Technology Societies (HATS): an organization with over sixty professional Associations for education and technology transfer.
- Oakridge Research Area/Savannah River Project: the top two nuclear R&D centers in the United States.
- Research Triangle Park: one of the largest joint ventures among four universities in the United States to assist commercial development.
- Georgia Institute Technology: the largest American public university for engineering research; over US$130 million last year with over 1000 full time scientists.
- National Oceanographic and Atmospheric Research Laboratory (NOARL): three research centers where ocean and atmospheric technology is developed.

KEY SUPPORT PROGRAMS

These include:

- National Aeronautics Space Agency (NASA): three of the national centers (US$7 billion) for developing all technologies used in final space payloads, (Marshall, Kennedy, Stennis).
- National Oceanographic Research Data Agency (NORDA): two east coast and major gulf coast (US$10 million) research centres to coordinate Navy R&D.
- Defence Advanced Research Programs Agency (DARPA): Considering locating HDTV (US$30 million) project at the new Georgia Institute of Technology Microelectronics Center.
- Sun Belt Institute: A University/Industrial/Government US$60 million group for supporting environmental research.
- S.E. Association Egg & Poultry International: Leading group to promote and demonstrate technology in the industry.
- Bobbin International: Major group to promote technology to the apparel industry.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Key opportunities in areas such as oceans industries, environmental technology, agriculture, pulp and paper, furniture, clothing, electronics and aerospace.

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2.1.2 Boston (New England)

The area has a population of about 9,600,000 people or four percent of the American population. Because of a tradition of high technology development (i.e. Route 128) and world class universities (eg. M.I.T., Harvard), New England spends about 2.5 - 3 percent of its GDP on R&D.

Two way trade between Canada and New England reached US$11 billion in 1988. Major imports were computers, semi-conductors, and telecommunications equipment although Canada exported US$630 million in advanced technology products to the region.

TECHNOLOGY TRENDS AND STRENGTHS

The December 1989 meeting of the New England Governor's Conference focused on the importance of biotechnology to the economic future of the region. Estimates are that by the year 2000, the value of the biotech industry in New England will be over US$100 billion. Economists forecast the creation of 100,000 biotechnology jobs in the region during this decade. New England is one of the world's top centers for biotech and biomedical research. There is a great opportunity for technology transfer, joint R&D, and joint ventures between Canadian and New England companies.

Computer software has become a growth industry in the region. There are over 1,500 software companies in Massachusetts alone with industry leaders such as Lotus, Index Technology, and Bitstream. The American headquarters of Cognos is located just outside Boston. The industry employs about 300,000 people. Many small and medium sized companies have expressed an interest in joint projects with Canadian companies.

The mini-computer industry continues to be a dominant force in the regional economy despite the nationwide slump in computer sales. Recognized industry leaders such as Digital Equipment Corp., Prime, Apollo/HP, and Data General are based in Massachusetts.

On the academic side the region is home to over 150 colleges and universities. For virtually every discipline, at least one of the top centers of study in the world is located in New England. Among these the most important are: Massachusetts Institute of Technology (M.I.T.), Harvard, Tufts University, Dartmouth College and Northeastern University.

Additionally, world class research institutes in oceanography (Woods Hole Oceanographic Institute), biotechnology (the Whitehead Institute), medicine (the Harvard hospitals), communications (the M.I.T., Media Lab) and engineering (the Charles Draper Stark Laboratories) are located in New England.

KEY ORGANIZATIONS AND SUPPORT PROGRAMS

These include:

- Massachusetts Office of International Trade
- Massachusetts Computer Software Council
- Massachusetts Biotech Council
- The New England Governors' Conference
- M.I.T. Industrial Liaison Program
- Harvard University Technology Transfer Office

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunities exist in ocean industries, computers, software, biotechnology, defence industries and instrumentation.

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2.1.3 Cleveland (Ohio, Kentucky, West Virginia and Western Pennsylvania)

This area is responsible for about US$20 billion in bilateral trade with Canada which is equal to that with the U.K., France, West Germany and Italy combined.

This territory is the home of fifty-five of the Fortune 500 industrial companies and thirty-three of the Fortune 500 service companies. It also has two foreign and twenty-five domestic automotive manufacturing plants and some of the largest producers of rubber, steel, electrical and consumer products.

TECHNOLOGY TRENDS AND STRENGTHS

Ohio's largest concentration of scientific expertise is the 2,400 people at the Wright Research and Development Center (WRDC) as well as the NASA-Lewis Centre and industry. Technology strengths exist in biotechnology (B.F. Goodrich), advanced manufacturing (Allen Bradley) advanced materials (WRDC) and avionics (General Electric, WDRC).

Western Pennsylvania has the third largest concentration of R&D after California and Massachusetts. Technology strengths exist in software, biotechnology, advanced materials and nuclear and energy systems (eg. Westinghouse).

KEY ORGANIZATIONS

In Ohio, these include:

- Wright Research and Development Center (military R&D)
- Ohio Technology Transfer Organization
- Dayton Area Technology Network (one hundred local high technology firms)
- Edison Centers (funding for technology development and transfer to local industry)
- Ohio Advanced Technology Center
- Small Business Innovative Research Center
- Environmental Protection Agency Research Center
- National Institute for standards and technology
- Battelle Memorial Institute

In Western Pennsylvania, they include:

- NASA Industrial Application Center at the University of Pittsburg
- Pittsburg High Technology Council (600 local high technology firms)
- Mellon Institute
- Westinghouse Laboratories

KEY SUPPORT PROGRAMS

In Ohio, these include:

- R&D contracts through the WRDC and the NASA-Lewis Research Facility
- Ohio Edison Centers which provide funds for technology development and act as clearinghouses for problem solving

In Western Pennsylvania, they include:

- the Ben Franklin Trust which provides matching funding for R&D
- National Environmental Technologies Applications Corporation which stimulates R&D and joint ventures in environmental areas

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The essential first step is to study the areas of industrial strengths and technology R&D strengths and trends outlined in this summary, decide what technology is desired, then contact the appropriate Trade Commissioner listed below for guidance as to possible sources. For contract development of technology in the space and aerospace sectors, Canadian companies should (1) reach the Commerce Business Daily, to learn about "Sources Sought" for various R&D tasks and "Requests for Proposal" for specific requirements, and (2) contact the Trade Commissioner at Wright-Patterson Air Force Base to discuss your technology requirements and receive suggestions on how to proceed, other contacts, etc.

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2.1.4 Houston (Southwestern United States)

The Southwestern States - Texas, Louisiana, Arkansas, Oklahoma, Kansas and New Mexico - represent approximately 10 percent of the American population and total employment is estimated in excess of 7 million jobs. Almost one-half of the jobs available are within the Houston Metropolitan Statistical Area and the Dallas-Fort Worth Metroplex.

The major industries - energy (68 percent), financial services, manufacturing (trade) and real estate - suffered from the 1980s oil slump. Defence-related manufacturing growth has slowed due to budget cuts. Some cities with strong economic anchors unrelated to oil and gas managed to escape the worst effects of the recession. Improvement is evident. Houston's energy industry has shifted its emphasis from exploration and production to refining and petrochemical manufacturing. And, the area economy has diversified and become less dependent on oil and gas, in general. Most major cities in the area have experienced job expansion in the last twelve month period. Employment growth in Texas is expected to average approximately 2.5 percent for the next two years. A broadening of the economy has left the area poised for steady growth and less prone to the boom and bust cycles characteristic of the past.

Canadian exports to the state of Texas total approximately US$1 billion and over US$450 million to the other five states.

TECHNOLOGY TRENDS AND STRENGTHS

Growing industrial diversity in the 1990's will be characterized by health care, biotechnology, computer, software, aerospace and telecommunications.

- *Health Care - The Texas Medical Center* (TMC) (Houston), a strong confederation of 41 institutions, is one of the largest in the world, employing 55,000 and is Houston's biggest employer, renowned for its cardiological and cancer research.
- *The Dallas Medical Action Group*, nine institutions to date, is aggressively raising its visibility in the area and internationally. A 7.1 percent gain in new jobs was experienced by the health service sector last year. More than US$1.3 billion in construction projects are in progress at TMC and, upon completion, will add another 6,500 permanent jobs there.
- *Biotechnology* - A significant number of biotechnology companies are emerging in Texas and New Mexico producing products and services including drugs, artificial joints and gene mapping and gene splicing techniques. Medical schools and research centers in both states encourage more technology transfer and commercialization and are receiving worldwide attention. The industry is moving from a science-oriented business to a product-oriented business. Biotech and related companies number close to 200 in Houston alone.

KEY ORGANIZATIONS

Major areas of research and development are conducted by the following institutions:

- Baylor College of Medicine and Center for Biotechnology (Houston, Dallas) - Molecular Genetics/Human Genome Research participation; Cardiology/DeBakey, Parkinson's Disease/Deprenyl Study; Other Neurological Disorders.
- University of Texas Health Science Centers (Houston, San Antonio) - Cardiovascular; Neurology/Stroke Victims; Reproductive Biology; Lyme Disease.
- University of Texas Southwestern Medical Center (Dallas) - Dowager's Hump.

- University of Texas Institute of Bioscience and Technology (Houston) - Major Medical and Agricultural Research.
- University of Texas Center for Biotechnology (Austin) - Insect Diagnostics for Agriculture.
- Texas A&M University/Texas Agricultural Experiment Station (College Station) - Brucellosis Project; Plant Genetic Engineering.
- University of New Mexico/Center for Non-invasive Diagnosis - Nuclear Magnetic Resonance (NMR).
- New Mexico State University/ Plant Genetic Engineering Laboratory - Rapeseed.
- Computers - Compaq Computer Corp. (Houston) is the largest success story, followed by Dell Computer and Compuadd in Austin, and Tandy and Uniden in Forth Worth.
- Landmark Graphics and Geo Quest have carved out niches in the computer-aided workstation market.
- The Microelectronics and Computer Technology Corporation (MCC) and Sematech consortia in Austin spawn additional high tech support industries.
- Software - More than 1,400 software developers have emerged in Houston, the largest of which is BMC Software.
- Aerospace - Aerospace contracting continues to assume a larger role in Houston's economic future due to NASA's presence. The two largest private space companies are located there, also - Space Industries and Space Services. Funding for the space station is expected to total US$2.1 billion in 1990.
- Grumman opened its Southwest Regional Development and Production Center to handle NASA and defence contracts in 1990. McDonnell Douglas, Westinghouse and Boeing have significant presence at the Johnson Space Center (JSC).
- The Fort Worth - Arlington area is heavily dependent on aerospace and defence through General Dynamics.
- Telecommunications - GTE and Fujitsu American relocated to the Dallas MSA in 1989. Dallas is also the headquarters for Ericcson's American operations.
- A consortium, the Bluebonnet Project (Austin), is comprised of eleven of Texas' largest universities, research institutes and corporations to create a statewide telecommunications network - one of the fastest-growing high-technology fields - using high powered computers.
- Texas Engineering Experiment Station (TEES) - Texas A&M ranks eighth nationally in research (eg. environmental research, space power, computer assisted design tools for circuit design and analysis).
- Texas Center for Superconductivity/ University of Houston
- Research Corridor/Centers of Technical Excellence - New Mexico
- Center for High Technology Materials
- Center for Micro-engineered Ceramics
- Los Alamos National Laboratories
- Sandia National Laboratories

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The technologies of primary economic important to the region parallel those vital to sustained economic growth of Canada - biotechnology, information technology and advanced industrial materials.

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2.1.5 San Francisco (Northern California, Colorado, Hawaii, Utah)

California is the sixth largest economy in the world and will be the fifth by the year 2000 with an economy estimated to be US$820 billion. California's US$500 billion economy is larger than Canada's and California creates 400,000 new jobs each year. California has 27 million people now and will have 33 million by the year 2000. California ranked first in new businesses opened in the United States and in new capital spending.

The Bay area has 5.6 million people and has an economy of US$125 billion making it the fourth largest market in the United States. High technology accounts for one-half of the manufacturing jobs and one-twentieth of California's exports.

Colorado offers many opportunities in the defence sector.

TECHNOLOGY TRENDS AND STRENGTHS

Northern California is the centre of many new trends in the four or five areas of technology that it dominates. As a source of technology there is probably no greater source in the world based on accessibility and ease of access.

Biotechnology

Biotech Bay is the centre of biotechnology developments in the United States with over 250 biotechnology firms headquartered here. Experts estimate that about 30 percent of the biotechnology activity in the United States takes place in Northern California. Like the computer industry, the biotechnology industry giants (eg. Genetech) are spinning off many new companies and technologies that could be attracted to Canada. However, few other locations including Canada have the critical mass of talent, climate, research facilities and support industries required.

Computer Hardware and Software, Telecommunications, Defence Electronics

Silicon Valley is the world centre for the computer industry. Most of the major computer chip manufacturers Intel (US$1.9 billion), National Semiconductor (US$1.8 billion), Chips and Technology, Fairchild, Advanced Micro Devices (US$997 million) are based here as are the major manufacturers of chip making equipment. While local market share of silicon equipment has fallen to around 35 percent, a large percentage of new developments in computer technology still comes from this entrepreneurial centre.

Also headquartered here are related industries such as: Asics, Cad Cam software development labs (eg. IBM); personal computer manufacturers (eg. Apple, Amdahl, Atari, Hewlett Packard, Tandem Sun), defence electronics (eg. CAE Link Singer, Harris, Litton, FMC, Avantek, California Microwave, Varian, Watkin Johnson, Scientific Instruments); telecommunications (eg. 3Com, Novell, Northern Telecom, Rolm) and space (eg. Lockheed Missiles and Space, Ford Aerospace).

KEY ORGANIZATIONS

Much of the early success in Silicon Valley is attributed to Stanford University. Stanford still runs a highly active technology transfer office that holds a large number of patents. Five other technology transfer offices exist in the area universities. Several private labs also have technology transfer offices.

Stanford is far from the only major university in the area. Other major institutions such as Berkley, University of San Francisco, San Jose State, are all within the Bay area.

On the industrial side such research facilities as the Xerox Research park in Menlo Park (home of the Macintosh ikon approach and desktop publishing to name a few), Stanford Research Institute (3500 researchers) are all potential sources of technology cooperation agreements and collaboration.

On the government side, major labs such as Lawrence Berkley (6000 researchers), Lawrence Livermore (7000 researchers) for weapons, materials and supercomputing are important.

The private sector has extensive research programs. For example IBM has over 2000 researchers at its St. Theresa research facility. Genetech runs one of the largest biotech/pharmaceutical commercial research and development labs in the United States.

KEY SUPPORT PROGRAMS

California is open for business. Over 25 percent of investment is from foreign sources and most of this investment is in the technology sectors.

Venture Capital

Silicon Valley is the home of 25-30 percent of the venture capital for high tech in the United States. This large venture capital pool supports a significant percentage of the R&D done by the small entrepreneurial companies in the Valley.

Defence Spending

NASA-Ames, Lockheed satellites, etc. are examples of military and space programs that are partially government funded and that support the local R&D community. In 1985 over US$30 billion in defence prime contracts were received by California firms. California receives over 20.8 percent of the prime defence contracts fuelling a large amount of high technology research and contracts.

Government

Government has played a limited role in the development of the Valley. Initially government was a large customer for chips. Now it accounts for less than 10 percent of the electronic parts sold out of the Bay Area.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

California is the centre of research in so many areas of interest to Canada that it is almost impossible to list them all. Aside from the vast potential offered by microelectronics, from its huge agricultural base, California funds biotechnology research that will have a great effect on Canadian agriculture. Other major efforts include the mapping of the Human Genome, a project estimated to be equivalent to going to the moon in its complexity.

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2.1.6 Seattle (Northwest United States)

The overall economic outlook for the Seattle post territory of Alaska, Washington, Oregon and Idaho continues to be positive and in particular greater Seattle and Portland. The foundation for this strong economy is Boeing's growing backorder of commercial aircraft worth US$85 billion; expanding software development houses, in particular Microsoft; diversifying forestry companies such as Weyerhaeuser; expanding Japanese investment in high technology manufacturing facilities in Portland which number seventy-one companies today. No figures are readily available on R&D expenditure in the territory; however, given the nature of two of the principal businesses in the territory (aerospace & software development) it would be above national averages. Also, above the national levels are the number of engineers, scientists and technicians. For example, Boeing has 15,000 engineers and 13,000 technicians on its payroll.

TECHNOLOGY TRENDS

Today, the technology industry in the Pacific Northwest is strongly backed by government, educational and industrial leaders. This support has contributed to the necessary ingredients for a bright future, including an existing critical mass of "home grown" technology companies with world-wide reputations, technology centres of excellence like the Technology Corridor in Washington and Oregon Center for Advanced Technology Education, strong technology centres in the leading universities and a highly trained work force. The future growth in the technology industry in the Pacific Northwest will come from three principal areas: expansion of existing companies, spin-offs from existing companies and relocation of established companies to this territory particularly from Japan. Published figures state the technology work force in this territory will grow by 50 percent in the next twenty years.

TECHNOLOGY STRENGTHS

The major technology strengths in this territory can be found in all aspects of commercial aircraft manufacturing and systems integration, defence aircraft and systems, space based radars, space stations, application software development, operating software systems, computer test equipment, biotechnology with emphasis on forestry and medical, oceans and atmosphere research and oil spill clean-up.

KEY ORGANIZATIONS

Most of technology development undertaken in this territory is done by the private sector in particular with the Boeing Company, the territory's largest employer (110,000 employees).

Boeing's following subsidiaries are responsible for most of the technology activity: Boeing Commercial Airplanes, Boeing Computers and Boeing Defence & Space Group. Other key private sector organizations include Microsoft, Microim, Aldus, University of Washington, Fred Hutchinson Cancer Research, Immunex, Tektronix, Mentor Graphics, Intel, and Weyerhaeuser. Government agencies actively involved in technology development include the Bonneville Power Administration and the National Oceanic and Atmospheric Administration.

KEY SUPPORT PROGRAMS

No programs exist, however Boeing Defence and Space Group is always interested in working with capable Canadian companies.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunities lie in the areas highlighted in the section on Technology Strengths.

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2.1.7 St. Louis (Missouri)

The population of the region is 5,141,000 (fifteenth in the United States). The major cities are St. Louis (population 2,420,000) and Kansas City (population 1,518,000). The gross state product is about US$92 billion and the labour force is 2,550,000. The state provides company headquarters for twenty-five Forbes 500 companies and sixteen Fortune 500 companies.

The key industries in Missouri are manufacturing (transportation equipment), agriculture (cattle and soybean), minerals and fuel (lead, cement and stone), construction, and military related industries.

Ranked in order of value of exports in 1988 are the following sectors:

- transport equipment: US$1.1 billion
- chemicals/chemical related products: US$239 million
- industrial machinery: US $200 million
- computers: US$200 million
- electronics: US$190 million.

Since 1984, total spending on R&D by the State of Missouri has totalled over US$50 million.

In 1989 approximately US$1.1 billion was funded by the federal government through the Small Business Innovation Research Program. Another US$1 billion in federal funds was passed to the centers for Advanced Technology.

In total, the federal government has spent more than $5 billion in Missouri for R&D in the past year.

TECHNOLOGY TRENDS/STRENGTHS

Large firms in the Missouri area such as Monsanto and Ralston Purina have been strong in the fields of biotechnology, biochemistry and genetics.

Recently, Monsanto has joined together with Washington University, also very strong in research capabilities, for a collaborative research venture. Over a period of eight years, ending in 1991, Monsanto will have given Washington University US$62 million for biomedical and biotechnological research.

The company also has built a US$150 million life sciences laboratory expanding the spectrum of their research. This complex will focus on biotechnology, genetics, and biochemical sciences. Ralston Purina has strong research capabilities in the food science sector.

General Dynamics, headquartered in St. Louis, is working with NASA to develop the first privately built rocket launch facilities.

McDonnell Douglas, a leader in aerospace and largest employer in St. Louis with 44,000 employees, received US$2.9 billion in government research funding in 1989 (12 percent of total defence research). The company is the nation's largest defence contractor, with more than US$8 billion in annual contracts. They are negotiating with NASA to build the Delta rocket launcher at Kennedy Space Center.

Other than these private companies, many learning institutions in the region have strong research capabilities and often work alongside the private companies in joint ventures.

There are about 1500 other technologically based companies in the area, with specific strengths in agriculture, robotics, aerospace (composite and advanced materials), biotechnology (human therapeutics, plant agriculture, animal agriculture, pharmaceuticals and diagnostics), engineering and computer sciences.

KEY ORGANIZATIONS/ SUPPORT PROGRAMS

In 1983, the Missouri Corporation for Science and Technology was created to strengthen the state's economy by encouraging the development of science and technology through various programs.

Private firms have underwritten sources of seed capital, such as in the Capital for Business Fund and the Gateway Mid America Fund I and II.

The Higher Education Applied Projects (HEAP) Fund was established in 1982. This program assists businesses in bringing new technologies to the market by using the higher education institutions in the area. The Missouri Department of Economic Development is in charge of administering this fund.

In Missouri, there are four Innovation Centers which started in 1984. The centers are located at University of Missouri campuses at Columbia, Rolla, St. Louis, and Kansas City. They were set up as support programs for entrepreneurs and innovators, helping firms at various stages of their projects. Approximately US$33 million in private funds have been made available for these centers. In addition to these four innovation centers which assist industry, research oriented Centers for Advanced Technology have been created through the University of Missouri at Kansas City, Washington University and University of Missouri at Rolla. Each institution will target specific technologies: telecommunications, plant technology, and manufacturing research, respectively.

The Center for Advanced Technology in Telecommunications/Computer Networking is being organized at the University of Missouri in Kansas City which will emphasize research, technology transfer, education/training and innovation.

The Center for Advanced Plant Technology at Washington University will genetically engineer plants to be stress resistant in their environment, thus leading to improved crop productivity and decreased cost. This technology will be transferred for commercial use.

On a larger scale, there are centers being organized by the private sector and the State of Missouri. In 1985, the St. Louis Technology Center opened as an incubator for smaller firms trying to establish themselves in the high technology industry. This center is the first enterprise of its kind in the area, capitalized with a US$4 million seed fund.

Most recent is the Missouri Research Park being built just outside of St. Louis. This park is the project of the University of Missouri in cooperation with other universities in the area. The park will concentrate its efforts on attracting companies that will use the strengths of the universities in the areas of agriculture, computer sciences, robotics, aerospace technology, biotechnology, and engineering.

A similar project is in the planning stages through the University of Missouri at Kansas City, where a sixty-two acre research park of similar capacities is being designed.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Major opportunities exist in:

- aerospace (composites, fine materials, avionics)
- biotechnology (human therapeutics, plant agriculture, animal agriculture, diagnostics, pharmaceuticals)
- electronics; and
- telecommunications.

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2.1.8 New Jersey

The gross state product is about US$157 million (1988) and the population is 7,721,000 (1988). Exports amount to US$6 billion (1988).

In 1988, the state's industrial and academic R&D laboratories of which there are over 700, spent more than US $14.7 billion. This represents roughly 10 percent of gross state product and accounts for 11 percent of R&D funds spent nationwide. These 700+ laboratories employ almost 170,000 scientists and engineers, or 43 per 1000 of the labour force, giving New Jersey the highest per capita concentration of scientists and engineers in the United States. New Jersey ranks third in the United States for the number of patents issued to residents, accounting for 10 percent of all American patents.

The following lists key industrial sectors, along with their rankings on a United States -wide basis:

- pharmaceuticals and healthcare (#1)
- chemicals (#2)
- rubber and plastics (#5)
- instrumentation/related products (#6)
- petrochemicals (#7)
- fabricated metals and leathers (#9)
- electrical and electronics equipment (#10) (but with a leading position in telecommunications).

TECHNOLOGY TRENDS

In 1985, New Jersey, the "Invention State," established the Commission on Science and Technology to stimulate economic growth through science and technology. Cooperation and cost-sharing are characteristic of the Commission's initiatives and the Commission is making strategic investments in university research and technology-based business targeted to New Jersey's economic future. The Commission is a partnership of academia, industry and government with all of these points of view reflected in its 18-member board. The Commission's strategy for economic development depends on building the technology infrastructure at research universities and on providing long-term support for R&D - to encourage industry and the federal government to match New Jersey's investments. These investments are targeted to four scientific fields identified as New Jersey's strengths: biotechnology, telematics (informatics), advanced materials, environmental protection technologies.

TECHNOLOGICAL STRENGTHS

The four scientific fields that have been identified as New Jersey's strengths reflect the industrial structure of the state in key areas such as pharmaceuticals, chemicals, food processing, rubber and plastics, and electronic equipment. To support its mission of generating economic growth through science and technology, the New Jersey Commission on Science and Technology has funded a network of eleven Advanced Technology Centers (ATC's) with the following research foci:

Biotechnology

- human health - (molecular genetics; structural biology; cell and developmental biology; and molecular pharmacology)
- food technology - better food processing technologies
- agriculture - application of tools of molecular biology to improve quality/productivity of plants, animals and environmental systems

Telematics (informatics)

- advanced computing devices geared to improving industrial design, productivity and quality control

Advanced Materials

- ceramics, fibre optic materials, optoelectronic materials, and superconductors

Environmental Protection Technologies

- hazardous waste reduction, recycling and recovery of waste plastics

The Commission has also funded the Technology Extension (TEX) Centers to facilitate the transfer of information and new technologies from university laboratories into New Jersey industry. These centers have been established in: polymer processing, information services, food processing, fisheries/aquaculture, cancer diagnosis and treatment.

KEY ORGANIZATIONS

A key organization in the promotion of science and technology is the above New Jersey Commission on Science and Technology with its network of eleven Advanced Technology Centers and five Technology Extension Centers.

In addition, there are over 700 industrial and academic R&D laboratories within the state of New Jersey. One of world class stature is the David Sarnoff Research Center located in Princeton, which is an independent contract facility renowned for its pioneering achievements in consumer electronics, materials science, solid state physics and communications. Today, its R&D efforts are targeted in three main areas: consumerelectronics and information sciences, manufacturing and materials research, and solid state research.

New Jersey is also home to a number of academic institutions with recognized expertise in technological areas of importance to the state. Among them are Princeton University, Rutgers University, the New Jersey Institute of Technology, the University of Medicine and Dentistry of New Jersey, and the Stevens Institute of Technology.

The Princeton Plasma Physics Laboratory, funded by the United States Department of Energy, conducts research into magnetic fusion energy. Its research and development in the field has led to advances in the state-of-the-art of numerous physics, engineering and technological disciplines with potential for non-fusion applications eg. plasma technology, vacuum technology, and neutron beam technology.

KEY SUPPORT PROGRAMS

The New Jersey Commission on Science and Technology funds a grants program (Innovation Partnerships) in partnership with the state's private companies to provide funds to support academic researchers pursuing investigations into immediate and specific industrial problems. The Commission's Business Development Programs include: Bridge Grants to help small research firms secure federal research funding to discover novel technologies to launch new businesses; a Venture Match program to team venture capitalists with promising enterprises; the Entrepreneurs Forum where business leaders share financial, managerial and marketing skills with technology driven entrepreneurs; a network of business incubators to provide new technology and science-based firms with space and support services linked to the state's universities and laboratories.

CONDITIONS OF ACCESS

The New Jersey Commission on Science and Technology has recently amended its policy on access by foreign firms to the technologies and expertise housed in its eleven advanced technology centres (ATC's) to permit Canadian firms and research institutions access as if they were New Jersey firms. This means that a Canadian firm can apply to become a member of an Industrial Advisory Board of a given ATC which would mean full access to the generic research performed by that ATC. Alternately, Canadian firms can enter into bilateral relationships with an individual ATC to access technology.

This improved access for Canadian firms and research institutions is predicated on reciprocal access by New Jersey firms and research centers to technology developments in Canada.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

There are excellent opportunities for Canadian firms to access technology in New Jersey's four areas of concentration: biotechnology, telematics, advanced materials, environmental protection technologies. In addition, technologies available from private research centers, like the David Sarnoff Research Center, can be licensed for specific applications.

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2.1.9 Washington D.C. (Mid-Atlantic States Region)

The prosperous 72,000 square mile mid-Atlantic corridor of the United States boasts a heavy concentration of technology-based businesses. With a population of 16 million consumers, the region is home to nine percent of American personal disposable income. The greater Washington-Baltimore metropolitan areas have a highly skilled workforce which in 1989 included 183,000 scientists and engineers. Fifty one percent of all technology professionals hold masters degrees and their average annual income is US$75,000. Defence, aerospace, electronics, telecommunications, and informatics are major industries. The Delaware Valley economic region which includes Philadelphia and environs is strongly influenced by the automotive, pharmaceutical, medical, and chemical sectors. Key mid-Atlantic exports include passenger automobiles and parts, plastics, chemical products, telecommunication equipment and computers.

TECHNOLOGY TRENDS

The national capital area (which encompasses adjacent counties in Maryland and Virginia) is the fastest growing major technology centre in the United States. Technology-related job creation is currently growing at a rate 250 times that of overall employment. By the turn of the century, it is predicted that the region will surpass California in national high technology prominence and become the American focal point for global activity in this area. Washington technology companies represent one fourth of the 4,000 new corporations formed in the region each year. More than 10 percent of the nation's biotechnology firms are located in Maryland, and the number is growing exponentially as newcomers and start-ups are lured to an industry area anchored by one of the world's premier biomedical research facilities, The National Institutes of Health, as well as the State-funded Maryland Biotechnology Institute. Metropolitan Washington is also a dynamic growth hub for information systems development and electronics manufacturing, as is Eastern Pennsylvania in the rapidly emerging life sciences field.

TECHNOLOGY STRENGTHS

Sub-regional strengths break out as follows:

Maryland
- biotechnology (over 119 firms) producing diverse range of products; Johns Hopkins University and other educational institutions
- aerospace, defence electronics (Martin Marietta, Bendix Field Engineering Corp.)
- computer systems (Integral Systems Inc., Computer Data Systems Inc., CompuDyne Corp.)
- test and measurement equipment (E.I.L. Instruments Inc., Telecommunications Techniques Corp.)

Delaware
- advanced materials (University of Delaware, Dupont)
- food processing (Cargill Inc., Conagra, Draper-King Cole, Perdue Farms)
- chemicals/specialty chemicals (du Pont, Hercules, I.C.I.)

Eastern Pennsylvania
- pharmaceutical, health care and chemicals (Smithkline Beecham, Rohn & Haas, Abbott Labs, Warner Lambert, Roher Group, etc.)
- instrumentation/related products (ie. medical device commercialization Thomas Jefferson University; Schott Optical and numerous other firms.)
- metalworking (Bethlehem Steel, Carpenter Technology Corp., Continental Wire & Cable, etc.)

Virginia

- electronic computer & telecommunications equipment (Fairchild Industries, Systems Technology Assoc., Genicom Corp, Flow General & Comdial)
- forest products (James River Corp, Chesapeake Corp.)
- specialized high-tech manufacturing (lasers/Digital Optromics, ISOMET; also silicon chips, interferon, rocket motors, robotics, etc. produced by a variety of companies).

KEY ORGANIZATIONS/SUPPORT PROGRAMS

A number of institutions of higher learning are heavily engaged in basic research that provides a foundation for follow-on commercialized technology. The Johns Hopkins University is a mid-Atlantic leader in this regard, with a US $300 million annual R&D budget devoted to work in the fields of biology, medicine and genetic engineering.

Montgomery County High Technology Council
Comprised of 150 area high technology firms, government research facilities, colleges and universities, this consortium is charged with establishing linkages between corporations, entrepreneurs and support industries.

Ben Franklin Partnership
Designed to promote advanced technology in mature as well as emerging industries, the partnership links state, private and educational resources in an effort to increase international competitiveness, recruit new investment, and support small spin-off businesses. The six year old organization has injected over US $105 million in state funds into Pennsylvania technology projects and has attracted more than US $400 million in private matching support. Grants have established four technology centers which provide joint R&D education and training, and entrepreneurial assistance to their respective regional clients.

Center for Innovative Technology (CIT)
The Ben Franklin counterpart in Virginia, CIT is a public/private sector partnership which endeavours to maximize scientific and technical talent at the conceptual, technology transfer, and commercialization stages of product development. The Centre supports three research institutes at various universities, 10 technology development centers, and seven innovation centers.

Regional Science and Technology Education Facilities
In addition, the greater Washington area is home to over 1500 intellectual property, patent and trademark attorneys, some 2000 industry associations (60 related to biotechnology alone), and the nation's fourth largest concentration of computer programming and related service centers. Venture capital companies are heavily represented throughout the region.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Key areas of opportunity for Canadian firms in the Pennsylvania to Virginia Corridor include those related to the biomedical, advanced materials, food processing, informatics and electronic industries.

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2.1.10 Los Angeles (Southern California, Arizona and Clark County, Nevada)

Southern California, Arizona and southern Nevada is home to approximately 22.5 million people. With an estimated gross regional product of US$412 billion (1989), Southern California alone ranks tenth in the world in economic size, slightly smaller than Canada. Five major technology concentrations exist in the following areas:

- Los Angeles Country; population 8.8 million
- Orange County; population 2.4 million
- San Diego County; population 2.5 million
- Ventura/Santa Barbara Counties: population 1 million
- Phoenix/Tucson, Arizona; population 3 million

California has some 13 percent of the country's industrial laboratories; their annual R&D funding level exceeds US$9.1 billion. California graduates 11 percent of the nation's engineers and scientists, while employing 17.1 percent and 12.2 percent respectively. California employs 18 percent of those working in the nation's commercial R&D labs and 17 percent of those working in non-commercial research organizations. California leads the nation in United States patents issued, claiming 7,000 of the 85,000 patents issued in 1987.

Major manufacturing sectors include: aerospace technology both military and civilian, communication/telecommunication, electronics, software, biotechnology, and scientific and medical instrumentation.

This region has several universities conducting technological research of international stature. These include the California Institute of Technology (CalTech) in Pasadena, the University of California, Los Angeles (UCLA), the University of Southern California (USC), the University of California, Irvine (UCI), the University of California, San Diego (UCSD), the University of California, Santa Barbara (UCSB), and the University of Arizona in Tucson.

TECHNOLOGY STRENGTHS AND TRENDS

Emerging application areas include the following:

- Aerospace: although the impact of defence cuts will be felt throughout the region's military-industrial complex, the missile-related sector will be particularly hard hit. Strong world-wide demand for commercial aircraft should enable aviation-related firms to weather Pentagon cost-cutting measures. Rockwell International, Lockheed, Northrop, Litton Industries, Hughes and McDonnel Douglas all rank among the major employees in Southern California.
- Communication/telecommunication equipment: microwave and high frequency communications, local area networks, fibre optics and cellular telecommunications.
- Electronics: advanced silicon integrated circuits (ASICs) for customized high-performance electronics, submicron integrated circuits and increasing miniaturization.
- Software: computer-aided software engineering (CASE), networking software, high-speed communications and robotic controls.
- Biotechnology: high resolution imaging technology and disease specific pharmaceutics and diagnostics.

- Medical/Scientific Equipment portable diagnostic instruments.
- Advanced materials: composites for aerospace and automobile materials and superconductor devices.
- Energy: alternative formulation gasoline/fuel, air pollution monitoring equipment and electric and natural gas-powered vehicles.

KEY ORGANIZATIONS

This region's well-endowed universities, both public and private, act as the driving force behind a large number of collaborative research and development efforts. These include:

- Jet Propulsion Laboratory (JPL), the nation's second largest federal laboratory, with R&D expenditures topping US$1 billion. JPL is an operating division of CalTech and manages facilities provided by NASA, JPL is the lead NASA centre for unmanned space exploration. JPL's primary roles include: exploration of the earth and solar system with automated spacecraft; design and operation of the Deep Space Tracking Network; and, scientific and engineering research in support of U.S. energy and security interests.
- NASA Industrial Applications Centre (University of Southern California): developing remote telecommunications capabilities to facilitate technical dissemination.
- National Supercomputer Research Center (UCSD): is geared toward translating the results of scientific research into applied engineering solutions. At the heart of the center is a Cray X-MP/48 supercomputer with eight million words of memory.
- National Engineering Research Center for Robotics Systems in Microelectronics (UCSB): mission is to apply robotics and automated process control to advanced semiconductor devices.
- Institute of Manufacturing and Automation Research (USC): in conjunction with University of Southern California and a consortium of companies, IMAR investigates new and advanced technologies for manufacturing while providing training for future production engineers.
- Research Institute of Scripps Clinic (San Diego); is a non-profit medical and research facility carrying out basic research in the fields of immunology, microbiology, virology, molecular biology and neurobiology.
- Salk Institute for Biological Studies (San Diego); half the institute's research is in neuroscience; the remainder focuses on cancer and AIDS research, particularly mapping human genes.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunity will continue to exist in the aerospace industry, telecommunications, electronics, medical instrumentation, software, and biotechnology.

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2.1.11 Minneapolis (Minnesota, Iowa, North Dakota, South Dakota, Montana and Nebraska)

The region produces some 4.3 percent of total United States gross domestic product (GDP). Two thirds of goods and services produced in the region are from the states of Minnesota (42.3 percent) and Iowa (24.5 percent).

The region represents 4.5 percent of the American population. Major concentrations of population are in Minneapolis-St. Paul, Des Moines, Iowa, Omaha and Nebraska.

Minnesota and Iowa dominate the manufacturing sector producing over 80 percent of the region's output. Agriculture is a major sector in all states with the region generating 17 percent of U.S. production. Mining is an important contributor to the economies of Montana and North Dakota.

Located in the region are twenty-four Fortune 500 firms. The Minneapolis-St. Paul area is considered a leading high-tech center in the United States. Minnesota employment in high-tech firms numbers about 180,000 with approximately 40,000 producing office and computing machines, the largest high-tech industry segment.

Key industrial/high-tech sectors include (1) office and computing machines; (2) medical devices; (3) scientific/testing instruments; (4) telecommunications equipment; (5) computer peripherals; and (6) electronic components. Minnesota manufactures/sells nearly US$5.2 billion of computers and electric/electrical equipment.

TECHNOLOGY TRENDS

A nation-wide computer industry slowdown has affected the state of Minnesota due to its production of mainframe, or large-scale computers, by firms such as Control Data, Honeywell and Unisys. It is estimated that mainframe sales have increased only 8.8 percent over the past two years versus 17.5 percent for the American computer industry.

Offsetting the slowdown in mainframe computers are the success stories of Cray Research (Minneapolis) in super computers and IBM (Rochester) in mini-computers and personal computers. Other sectors experiencing high growth trends are medical devices software development and biotechnologies.

TECHNOLOGY STRENGTHS

While R&D is funded in university laboratories by federal, state and private sectors, the overwhelming thrust in technological research is performed by individual private companies. Specific firms are identified below by key areas of technological strength:

Key Technology	*Specific Firm (major products)*
Computers	• Cray Research (large-scale scientific computers) • Control Data Corp. (main frame computers) • Unisys (mainframe computers) • IBM (mini-computers and PC's)
Medical Devices	• Medtronics (pace makers, heart valves) • 3M (health and safety products) • Starkey Laboratories (hearing aids) • St. Jude Medical (heart valves)

Software	• National Computer Systems (financial systems for bank trust departments) • Lawson Associates (business applications) • MicroEd (educational software) • MECC (educational software)
Biotechnology	• Life Systems (disposable medical devices) • Incstar (hormones, measuring kits) • Northrup King (seeds) • Pioneer Hybrid (seeds)

KEY ORGANIZATIONS

Key organizations involved in the high technology development include the following: the Minnesota Department of Energy and Economic Development (St. Paul), the Greater Minnesota Corporation (Minneapolis), the University of Minnesota (St. Paul), the Minnesota Trade Office (St. Paul), the Iowa Department of Economic Development (Des Moines), the Nebraska Department of Economic Development (Lincoln), the North Dakota Development Commission (Bismarck), the Governor's Office of Economic Development (Pierre, South Dakota), and the Montana Department of Commerce (Helena).

KEY SUPPORT PROGRAMS

The thrust of support programs by the individual states is aimed at attracting new industry to the state and developing increased economic growth. Numerous options for achieving these goals are utilized, including joint ventures, financial packages/incentives, R&D support by state universities, etc.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunities exist for Canadian firms and research organizations with the companies identified in the prior section on Technology Strengths. Product sectors/technologies include medical devices, computers, peripheral equipment, software, semi-conductors testing equipment, process control devices, telecommunication systems, printed circuit boards, robotics, and electronic/mechanical components. Opportunities are not limited only to large companies as Minnesota is home to more than 2,100 high-tech companies, many of which are small, entrepreneurial, niche market, high-growth firms.

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2.1.12 Chicago (Illinois)

Illinois, with approximately 11.6 million people, ranks sixth in terms of total American population. Recent figures indicate that Illinois' gross state product is about US$209 billion, fourth in the nation. Expenditures on R&D in the state totalled US$5.4 billion in 1987, approximately 2.6 percent of the state's gross domestic product, with R&D expenditures in the industrial sector accounting for almost 79.8 percent of the total amount spent. Presently, Illinois ranks eight in the United States, in terms of funding for R&D and employs 200,500 scientists and engineers (35 for every 1,000 members of the labour force) in its numerous academic institutions, research facilities and businesses. The key industrial sectors in Illinois that are most involved in R&D are microelectronics, medical electronics, telecommunications and pharmaceuticals. In addition, Illinois is a large financial center with over 1,200 banks and 400 savings and loan institutions which provide the capital to finance the continual expansion and growth of high-tech industry in the state.

TECHNOLOGY TRENDS

One of the most significant trends has been in the area of technology commercialization. University researchers, private industry, and government officials have all recognized the importance of collaboration on high technology projects; thus, funding has been provided to universities and federal laboratories to help identify and support emerging Illinois businesses involved in technological research.

The Argonne National Laboratory-University of Chicago Development corporation (ARCH) is an example of technology commercialization at work in Illinois. ARCH is an actual corporation formed strictly to facilitate commercial development of scientific and technical intellectual property originating at the university and national laboratory. This unique entity has the ability to license patents, to bring together venture capitalists and investors, to provide market studies and other information to prospective participants, to obtain financing for R&D, and to create new companies.

TECHNOLOGY STRENGTHS

Illinois has several high-tech firms that are leaders in their fields. For example, Motorola is the national leader in new cellular telephones for cars as a result of a multimillion dollar research and development effort. Several Illinois companies are leaders in computer hardware and software, modems, and data communications equipment, such as Zenith, a major manufacturer of personal computers. Gould Incorporated has emerged as a total electronics company manufacturing mini-computers, medical instrumentation, test and measurement instruments, defence systems, and a variety of electronic components.

As Illinois is the home of several major pharmaceutical companies and nationally recognized medical centers, the state is a leader in medical research, particularly in the area of advanced pharmaceuticals, genetic engineering and the development of sophisticated diagnostic equipment for the early detection of various diseases. Companies such as Baxter Travenol Laboratories, American Hospital Supply Corp., G.D. Searle and Company, Abbott Laboratories, and Smith Laboratories are just a few of the more than 350 producers of medical technology-related equipment and products in the state.

In addition, Illinois is the site of five federal laboratories, including Argonne National Laboratory, the nation's leading center for energy research and related scientific studies.

KEY ORGANIZATIONS

The principal S&T organizations are:

- Governor's Commission on Science and Technology (Illinois Department of Commerce and Community Affairs) which was established as a link between university research facilities, government, and private business.
- Chicago High Tech Association (not-for-profit) which serves as a resource for information on numerous programs and provides technical assistance.
- Argonne National Laboratory which is dedicated to energy research and related scientific studies.
- Fermi National Laboratory which is one of the world's foremost facilities dedicated to the study of elementary particles.
- University of Illinois at Urbana-Champaign which houses two supercomputer centers and conducts extensive research programs in supercomputing, microelectronics, and agriculture.
- University of Illinois at Chicago which has developed the Chicago Technology Park to commercialize biotechnology research.

KEY SUPPORT PROGRAMS

One of the primary focuses in Illinois has been on the cooperation between universities and technology-based businesses in the area of research and development. The State of Illinois Department of Commerce and Community Affairs has established several programs in which the government can operate as a link between academic research facilities and private businesses. Through the Technology Transfer and Commercialization Program, universities and federal laboratories obtain funding to help identify and support emerging Illinois businesses by making their faculty and research facilities available for collaboration on technical and management problems. In addition to two new university-associated technology parks - the Chicago Technology Park and the Evanston/University Research Park - several Technology Commercialization Centers have been established:

- the Basic Industry Research Institute at Northwestern University
- the Biotechnology Center at the University of Illinois at Chicago
- the Center for Supercomputing Research and Development at the University of Illinois at Urbana/Champaign
- the Materials Technology Center at Southern Illinois University at Carbondale
- the Center for Advanced Manufacturing and Production at Southern Illinois University at Edwardsville
- the Microelectronics Technology Center at the University of Illinois at Urbana/Champaign
- the Plant Molecular Biology Center at Northern Illinois University and Argonne National Laboratory
- the National Center for Supercomputing Applications at the University of Illinois at Urbana/Champaign

In addition to the commercialization program, the Department of Commerce and Community Affairs has targeted several other programs to assist high-tech businesses in R&D:

- Development Assistance Programs aimed at providing below-market interest rate loans with flexible payment schedules to small businesses and assisting beginning companies as an "incubator" to lower their start-up costs
- Financial Assistance Programs provide financing for projects which may not otherwise attract traditional lenders or venture capitalists and for technology-based companies for buildings, machinery, equipment, working capital, and organizational expenses associated with research and development

- Resource Technical Assistance enables businesses, industry and government to tap the expertise of university faculty members across the state and provides continuing support for new programs to advance technology in Illinois.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The key opportunities in Illinois would be in the areas of medical electronics, computer science, pharmaceuticals, and telecommunications.

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2.1.13 Wisconsin

Wisconsin, with a population of about 4.85 million, ranks seventeenth in the country. Recent figures indicate that Wisconsin's gross state product is US$76.9 billion, seventeenth in the nation. Expenditures on research and development in the state totalled US$1.5 billion in 1987, approximately two percent of the state's gross domestic product, with R&D expenditures in the industrial sector accounting for 78.6 percent of the total amount spent. Presently, Wisconsin ranks twenty-second in the United States, in terms of funding for R&D, and approximately 86,600 workers (34 for every 1,000 members of the labour force) are scientists or engineers. Wisconsin's key industrial sectors include the manufacturing of electrical machinery and equipment, transportation equipment, fabricated metals, paper and allied products and food processing. Currently, the manufacturing sector provides roughly 515,000 jobs in Wisconsin and contributes 22 percent of the state's personal income. Agriculture is another major component of the economy, with dairy products making up almost 60 percent of the contribution to the income of farmers. Wisconsin is the nation's leader in the production of milk, cheese, butter and many dry and condensed milk products.

TECHNOLOGY TRENDS

One of the strongest thrusts in technology development in the State of Wisconsin has been in the area of biotechnology. In 1987, Governor Tommy Thompson established the Governor's Council on Biotechnology and gave it the responsibility of making recommendations for ways of improving the biotechnology industry in the state.

TECHNOLOGY STRENGTHS

Due to its large number of university research facilities and incubator programs, Wisconsin has significant strength in the area of biotechnology, agriculture and food technology development. Application of this research and development has contributed to the success of the food and dairy processing industry in Wisconsin.

KEY ORGANIZATIONS

The principal S&T organizations are:

- Technology Development Fund (Wisconsin Department of Development) which serves to support research and development of significant new technology for Wisconsin business growth, retooling and/or diversification
- University of Wisconsin, at Milwaukee, Office of Industrial Research and Technology Transfer, which works to facilitate the dissemination of important and valuable research by disclosure and/or patenting
- University of Wisconsin at Madison which houses numerous research facilities such as the Biomedical Engineering Center, College of Medicine, Energy Research Center, Wisconsin Center for Applied Microelectronics, and the biotechnology Transfer Office.

KEY SUPPORT PROGRAMS

The Governor's Council on Biotechnology has come up with a comprehensive plan to increase state funding in the area of biotechnology, with a cost of US $1.5 million for the state fiscal year 1989-90 and US $2.9 million for the 1989-91 biennium. The Council recommends:

- the adoption of a regulatory policy for biotechnology which relies on the federal regulatory framework which has already been established
- the improvement of the availability of venture and/or investment capital for biotechnology companies and other technology-based businesses
- a technology based "incubator" program which assists small companies through reduction of start-up costs
- the provision of state funding for statewide programs provided by the University of Wisconsin's Biotechnology Transfer Office
- funding for partnerships of academic and industrial researchers to develop products and processes for commercial applications
- the creation of an office in the Department of Public Information to develop more biology-related educational activities from primary school through high school.

CONDITIONS OF ACCESS

Conditions for licensing agreements are between the companies taking part in the venture unless the Wisconsin company has received state funding for the development of a particular technology. In this case, the state requires that any production resulting from a business alliance of a Canadian and Wisconsin company takes place in Wisconsin.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

In Wisconsin, the areas of biotechnology, food processing, and agriculture and food technology (dairy products in particular) would provide opportunities for Canadians.

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3.0 WESTERN EUROPE

3.1 EUROPEAN COMMUNITY (E.C.) - ORGANIZATION

The twelve member states of the E.C. (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and the United Kingdom) are engaged in the process of completing their internal market. The current exercise will remove all remaining internal barriers to the free movement of people, capital, services and goods. The resulting single market, which should be largely achieved by the beginning of 1993, would have a combined population of 330 million people and 25 percent of the world's GDP. ● ●

To encourage European companies to work together in developing new technologies, the Community has developed complementary research and development programs to those of their member states to support the need for common standards and the economic integration brought about by the completion of the single market. While the amount of funding is relatively modest in percentage terms (only two percent of total R&D spending in Europe) for the last years, it has an important catalytic effect, in promoting transnational cooperation, and in some sectors, especially in enabling technologies, such as telecommunications and information technology, E.C. contributions represent a large percentage of total funding available.

Total R&D expenditures of the E.C. R&D programs is approximately 2 billion ECUS a year which represents only 50 percent of total funding as most programs are cost-shared. The current instrument used for E.C. R&D activities is the *Framework Program of Research and Technological Development*. The first one started in 1983 with major programs such as ESPRIT. The third one is being approved by the Ministers of Research of the 12 members and will be in place for the next five years with a budget of approximately 10 billion ECUS (ie. C $14 billion).

TECHNOLOGY TRENDS

The current priorities are:

- information technologies and telecommunications with, for example: ESPRIT II (budget of 3.2 billion ECUS);
- modernization of industrial sectors with materials research, technologies, production and aeronautics;
- environment with a budget doubled for this sector in the new framework program - including participation in the global change programs;
- life sciences and technology with three new programs: biotechnology and agro-industrial research as well as biomedical and health research and human genome research programs in addition to a major action in the social programs of the E.C. (outside of new research program) for AIDS and cancer;
- energy, which has always been a strength of the E.C. especially in thermonuclear fusion program; this sector is however receiving a slight decrease in budget.

TECHNOLOGY STRENGTHS

The catalytic role of the E.C. has been very successful in correcting the attitudes of Europeans - they do today work together - and are rapidly improving the R&D situation. Recognizing that rapid improvement and with the perspective of the large industrial market of 1992, interest has clearly been shown by the United States and Japan to work closer to Europe - even though in sectors such as information technologies, Europe is still behind its competitors. Europe is however a leader in fundamental research, especially today in the sector of thermonuclear fusion and all technologies related to nuclear research.

KEY ORGANIZATIONS

Most research funded by the E.C. is contracted out to industry, universities and member states' government laboratories on a 50/50 basis.

The Community also has intra-mural research conducted at the four facilities across Europe regrouped in the *Joint Research Centre (JRC)*. It was reorganized in July 1989 and divided into research institutes reflecting new trends but also more clearly responding to the E.C. role of establishing standards and covering safety aspects. This establishment has over 2000 scientists and works partly on a cost recovery basis. The main Institutes of the JRC are Environment, Remote Sensing, Nuclear Research (fission and fusion, including management of radioactive waste), Advanced Materials, a Bureau of Reference and Telecommunications/ Information Technology.

In addition to the JRC and the Framework Program of R&D where most of the research is done, the E.C. has training programs such as COMETT and ERASMUS, has demonstration programs such as THERMIE, and has a regional policy which provides funding for regional development such as installation of telecommunications equipment through the STAR program.

The E.C. is also an active member in the EUREKA initiative which has engaged 6.4 billion ECUS for research work.

The E.C. is also an active member of the COST which stands for Cooperation in Sciences and Technology. The COST structure regroups the twelve E.C. member states plus Norway, Sweden, Finland to provide a framework for specific projects in which all these countries are free to participate.

KEY SUPPORT PROGRAMS

Existing programs and the new programs (under the new Framework Program for 1990-1994) are organized under specific themes.

FIRST THEME: ENABLING TECHNOLOGIES

Information Technology and Telecommunications

Information Technology (I.T.)

ESPRIT: (Strategic European Research Program in Information Technologies)
The program has a budget of 1.6 billion ECUS for the period of 1989-1993. ESPRIT was launched in 1984 and carried out 277 joint projects, more than half of which resulted in industrial applications. The second phase ESPRIT II will remain on precompetitive research, but the emphasis will be placed on demonstration activities for the preparation and validation of standards and for integration of I.T. It will also deal with basic research, especially in cognitive sciences.

Telecommunications

RACE: (Research in Advanced Communications for Europe)
Its aim is to develop technologies and standards needed for the future broadband integrated network - with a budget of 550 million ECUS (over C$700 million) for the 1987-1991 period. It will

concentrate on high speed integrated circuits, integrated opto-electronics wideband switching (synchronic/asynchronic). RACE has currently 88 projects underway.

Development of Telematic Systems in Areas of General Interest

This new activity is of prenormative research character. A limited number of experimental development activities concerning the validation of common functional specifications will ensure interoperability of systems, peripherals and telematic networks at trans-European level.

Industrial and Materials Technologies

The E.C. has currently one program of 500 million ECUS (1989-1992) called BRITE-EURAM which regroups two programs as both had the same objective: to contribute to the rejuvenation of the European manufacturing industry by strengthening its scientific base. This program is a combination of BRITE (New Technologies for Manufacturing Industries) which was adopted in 1985 and carried 224 projects, and EURAM (European Research in Advanced Materials) adopted in 1986 and financed 84 projects.

The JRC will contribute to this work, especially on the prenormative aspects on advanced materials, the preparation of nuclear and non-nuclear reference materials.

SECOND THEME: MANAGEMENT OF NATURAL RESOURCES

Environment and Marine Sciences and Technologies

The E.C. has set up two research programs: STEP (Sciences and Technology for Environmental Protection) with a current budget of 75 million ECUS for the 1989-1992 period and; EPOCH (Climatology and Natural Hazards) with a budget of 40 million ECUS for the same period. The new Framework Program has more than doubled the current budget for environmental research. The 1990-1994 period budget is 514 million ECUS.
The Environment Institute of the JRC will also contribute to research in the environmental sector. A close co-operation exists between the JRC and the European Space Agency on the application of remote sensing to these environmental problems, as well as with EUREKA in the frame of the EUROTRAC project.

Life Sciences and Technologies

The E.C. has a long-term strategic objective which is to develop European potential for understanding and using the properties and structures of living matter. The programs are as follows:

- *Biotechnology*
  The BAP program (Biotechnology Action Program) came to a close in 1989. The BRIDGE program, with a budget of 100 million ECUS for the 1989-1995 period is its successor with very similar objectives. However, it is expected that both budget and goals of the BRIDGE program will be expended in light of the new Framework Program with a special concern attached to ethical implications and their relevance to industry.
- *Agricultural and Agro-Industrial Research*
  Based on biotechnology research, the E.C. has two other programs: ECLAIR which will apply biotechnology research to the agro-industrial sector (80 million ECUS for 1988-1993), and FLAIR, 25 million ECUS for the same period, which deals with applications in food stuffs sector and includes research on hygiene, safety and health, nutrition and toxicology.
- *Biomedical and Health Research*
  This is one of the rare concerted action programs: the E.C. pays only for the cost of the coordination of the excellent medical research done in members states.

- *Life Sciences and Technologies for Developing Countries*
  Essentially this deals with tropical agriculture, medicine, health and nutrition.

Energy

Currently the E.C. has five programs in the energy sector:

- a thermonuclear FUSION program (1988-1996), 745 million ECUS is being carried out under JET (Joint European Torus).
- the JOULE program (122 million ECUS, 1989-1992) investigates possibilities in the non-nuclear energy sector.
- a program to manage Radioactive Waste (79.6 million ECUS, 1990-1994).
- a program for decommissioning nuclear installations (31.5 million ECUS, 1989-1993).
- TELEMAN (19 million ECUS, 1989-1993) is devoted to remote handling in hazardous or disordered nuclear environments

THIRD THEME: UPGRADING OF INTELLECTUAL RESOURCES

The program Human Capital and Mobility (budget of 518 million ECUS) is to help mobility and training of scientists of government research labs, private sector or universities. It will build networks of scientists and foster utilization of large scale facilities.

CONDITIONS OF ACCESS

Non-European participation in programs is strictly controlled. Those R&D programs have been designed to foster intra-community cooperation and international competitiveness. Their access is limited to E.C. member state companies, research institutes and universities. However, certain programs are open to European Free Trade Association (EFTA) countries which all signed a framework agreement on science and technology with the E.C.. Some programs are open to non E.C./non EFTA countries if legal instruments exist between the E.C. and that country. For example, the Fusion or the STEP programs are open.

Because of the 1976 Framework Agreement for Economic and Commercial Cooperation, Canada has access to information on these programs. Exchange of scientists is also taking place for Canadian companies. The current situation is as follows: if a project involving two or more E.C. member state partners, is of interest to a Canadian company, either as a subcontractor or as a partner, the E.C. would allow the Canadian partner to participate on the basis that he is bringing in added-value to the project, all E.C. partners agree to have an extra partner, and no transfer of funds takes place (which means that the Canadian partner would have to bring his own research funding). Research can be done in Canada, but the bulk of the project has to be done in Europe.

For the purpose of the E.C. (and EUREKA) projects, a Canadian company with a base in Europe is considered as a European company provided there is a research facility located in Europe. A sales office is insufficient. A presence in Europe would definitely be advantageous to gain access to the E.C..

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The major opportunities are those contained in the technology profiles of the member states.

In addition the best source of information on existing E.C. projects and opportunity for cooperation is the ECHO data base. ISTC and NRC are on line with this data base. Other sources exist, for example the NET (Network of Environmental Technology Transfer) which is a specialized network giving services to all European environmental industries.

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3.2 FRANCE

With a GDP of about FF 4,000 billion (C$800 billion) and a population of 56 million, France is a major force in Europe. Its major exports are machinery and transportation equipment, chemicals, food stuffs, agricultural products, iron and steel products, textiles and clothing. Because it has to import a large part of its energy, France has opted for nuclear energy and has the largest civilian nuclear program in Europe.

Expenditures on R&D amount to about 2.3 percent of GDP. Industry finances about 41 percent of the country's R&D expenditures.

TECHNOLOGY TRENDS

France has placed a priority on industrial technology development and rapid transfer of results to industry. To this end, France uses major national programs, involving industry, in the following areas: biotechnology for pharmaceutical production, electronics, transportation, natural resources, new materials and chemistry.

More than 80 percent of France's research personnel and budget is tied up in four areas: aerospace, telecommunications, nuclear energy and defence. Recent budgetary allocations have increased government support of industrial R&D in; E.C. programs (JESSI, HDTV); EUREKA; agriculture and food; TGV third generation; cleaner automobiles; innovation assistance to small and medium sized enterprises, European space program (Ariane V, Hermès, Columbus, SPOT); and Aeronautic programs (Airbus, A330 and A340).

TECHNOLOGY STRENGTHS

Through major programs, France has developed particular strengths in space technology (Ariane), aircraft (Airbus), railway technology (TGV), digital telephone networks and nuclear power. Key firms in these areas include Aérospatiale, Airbus Industries, Alathcom, CIT Alcatel and Cie Générale d'Electricité respectively.

KEY ORGANIZATIONS

Lead organizations in technology development are:

- *CNRS (Centre national de la recherche scientifique)*
  This major research facility, which is the largest basic research organization in Europe, interacts with industry through:
  - joint research projects
  - the issue of licenses for developments produced within CNRS
  - the creation of small businesses to develop particular projects
  - secondment of researchers to private companies
  - consultancy to industry
  - training of industrial technologists in new technologies
  - a data bank service which answers inquiries from industry on particular technologies
  - an industrial relations committee in which hundreds of researchers and people from industry jointly conduct analyses to develop strategies for new technologies

- a network of chargés de mission for industrial liaison located in each of the regions. In addition, it has a directorate for scientific and industrial information which produces publications, audio-visual aids, and exhibitions to put across information about new technologies.

- ANVAR (*Agence nationale de la valorisation de la recherche*)
  ANVAR is a national agency with independent economic status, and reports directly to the Minister of Research and Industry. It has 350 employees in 24 regions. It carries out its role by:
  - providing information to promote and encourage innovation
  - helping to develop and commercialize inventions arising from research carried out in government and private research establishments and industry
  - giving advice on public financial assistance
  - giving direct financial assistance for research and innovation.
  - COFACE (*Compagnie Française D'Assurance Pour le Commerce Exterieur*) COFACE in collaboration with ANVAR, offers financial assistance of up to 75 percent of the cost of market research, to enable companies to assess the market for their innovations. It usually covers all marketing expenditures, including exhibitions, use of consultants, transportation and production of samples.

Other important organizations include l'Institut National d'Etudes et de Recherches Médicales (INSERM), l'Institut Français de Recherche sur les Technologies de la Mer (IFREMER), l'Institut National de Recherche en Informatique et Automatique (INFRIA), l'Institut National de Recherche en Agronomie (INFRA) and the Commissariat à l'Energie Atomique (CEA).

KEY SUPPORT PROGRAMS

The most important programs having an international dimension include the following:

- *EUREKA (excluding the JESSI Program)*
  France is participating in 127 out of a total of 297 projects under the EUREKA program. Total funding for the EUREKA program so far is 5.5 billion ECUS, including 4.1 billion ECUS for projects with French participation. These projects with French participation are in the following areas: biotechnology/biomedical, robotics/advanced manufacturing (CAD/CAM), informatics, microelectronics, communications, new materials, energy, lasers, transportation, oceanology/environment.

  The French government is providing some FF 700 million (for 1989) in financial assistance to its national participants in EUREKA projects.
- *European Laboratories Network*
  The French government is supporting financially the participation of some 400 French laboratories in this network of the Council for Europe (twenty-one member states). This program encourages cooperation between small European research teams wishing to participate in E.C. programs.
- *CNRS*
  The CNRS has co-operative agreements with thirty-two countries including Canada's National Research Council and has representatives at certain embassies abroad, with the purpose of seeking new technologies for international technology transfer.

- *ANVAR*
  ANVAR has two offices in other countries, one being Bonn, West Germany and the other in Washington, D.C. It helps French companies to mount international operations and will assist them in promoting new products and processes abroad. It also helps them to establish links with foreign firms in the same field.
- *CPE*
  The Centre for Evaluation and Prospective Development is a network that collects scientific, technological, industrial, economic and social data world wide, but especially from the United States, Japan, the Scandinavian countries and Germany, and makes them available through publications.
- *ORSTOM (Institut Francais de Recherche Scientifique pour le Developpement Scientifique en Co-operation)*
  This agency is a public scientific and technological research establishment (EPST). It makes available the national potential in science and technology and provides support mainly, but not exclusively for the francophone countries overseas.
- *Bilateral Agreement*
  Under the bilateral Science and Technology Cooperation Agreement with Canada, some thirty scientists from each country have the opportunity to work in foreign laboratories every year.

CONDITIONS OF ACCESS

Since French firms are usually given preferential treatment, a corporate presence in France or a strategic alliance with a French firm would facilitate access to French technology.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Canadian opportunities lie largely in areas that complement French strengths. Those include ocean industries, wood products, urban transportation, environmental equipment, telecommunications, electronic components, food processing and advanced manufacturing technologies.

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3.2.1 Rhône-Alpes

The Rhône-Alpes region of France represents approximately 10 percent of that country's socio-economic activity as defined in the following indicators (1988):

- 10.7 percent of exports
- 9.4 percent of the population
- eight percent of surface area of the country
- 11 percent of French patents filed in the region
- 10 percent of National R&D support goes to the region.

The three major urban areas are Lyon, Grenoble and Saint-Etienne. Some 30 percent of the work force is employed in five major industries; (1) mechanical engineering, truck building and arms manufacturing; (2) metallurgy; (3) electrical and electronics engineering; (4) textiles; (5) chemicals and pharmaceuticals.

The region has the second largest concentration of educational and research facilities after Paris. The region has some 20,000 researchers.

TECHNOLOGY TRENDS

Technology development is centred around five principal thrusts (pôles):

- industrial production technology (at Saint-Etienne and Roanne)
- robotics and automization (at Valence)
- electronics (at Grenoble, Chambery and Pays de Gex)
- genetic and medical engineering (at Lyon)
- plastics, plastic transformation and composites (at Oyonnax).

TECHNOLOGY STRENGTHS

A number of large firms in the region (eg. Pechiney, Mérieux, Rhône-Poulenc, Thomson-Brandt, Saint-Gobain, Compagnie Générale d'Electricité) have been foci for the development of technological strengths in areas such as metallurgy, chemistry, biotechnology, glass, trucks, electrical and electronics engineering as well as energy (eg. nuclear power).

KEY ORGANIZATIONS

The region has a concentration of both public and private technology development organizations.

In Rhône-Alpes, there are some 240 publicly funded laboratories and research centres including CNRS Laboratories (2,000 researchers), Institut National de la Santé et de la Recherche Médicale (25 units), Centre National d'Etudes des Télécommunications (specialized in micro-electronics and integrated circuits), Office National d'Etudes et de Recherches Aérospatiales, Institut National de la Recherche Agronomique.

In addition, there are international institutes such as the Centre International de Recherche sur le Cancer and the Centre Européen pour la Recherche Nucleaire, the Laboratoire des Champs Intenses, l'Institut Von Laue-Langevin and the Synchrotron.

Research in the region is also supported by 20 professional technical centres, including:

- French Textile Institute (Lyon)
- Paper Technical Centre (Grenoble)
- Leather Technical Centre (Lyon)
- Mechanical Industries Technical Centre (Saint Etienne)
- French Petroleum Institute (Lyon)
- Aluminum Technical Centre (Voreppe)
- Plastics Technical Centre (Oyonnax).

The major firms mentioned earlier also have technology development units. In fact, private research in Rhône-Alpes represents:

- 50 percent of French research in textiles
- 42 percent of the national research in non-ferrous metals
- 27 percent of chemical research
- 100 percent of research in high and very high voltage electricity

KEY SUPPORT PROGRAMS

There are no specific regional programs. Rhône-Alpes based firms submit their request for assistance in innovation research to the Lyon offices of the two appropriate Government Agencies:

- ANVAR (Agence Nationale pour la Valorisation de la Recherche)
- DRIR (Direction Régionale de l'Industrie et de la Recherche)

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The key areas of opportunity are electronics, telecommunications, nuclear energy, hydraulics, plastics and composites, fine and agricultural chemicals and pharmaceuticals. The Ontario government has recently signed an agreement for technological cooperation with this region; one of the so-called "four motors of Europe".

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3.3 WEST GERMANY

With a population of approximately 61 million, and a GDP of about DM 1,915 billion (C$1,320 billion) West Germany invests 2.9 percent of its GDP in research and development making it Europe's biggest investor in R&D. Some 64 percent of R&D is funded by industry. Only about 22 percent of the federal R&D budget is spent on defence related R&D.

West Germany is among the world's largest producers of vehicles, machine tools, machinery, chemicals, ships, iron, steel, coal and cement. It is also important in the areas of mechanical engineering, electrical engineering, synthetic material processing, plastics, office and data processing equipment, pulp and paper machinery, non-ferrous metals, foodstuffs, environmental technology, biotechnology and beverages.

TECHNOLOGY TRENDS

Germany, like Japan, has noted the closer integration of basic research with technology and is moving to strengthen its applied basic research base both in government funded research institutes and in industrial laboratories. In 1988, 20 percent of the federal government's total expenditures on R&D were in basic research.

In the 1988 Report of the Federal Government on Research, the following technical areas were identified as major recipients of funds from the Federal Ministry for Research and Technology in 1987 (in excess of DM 50 million);

Living Conditions - Preventative Research; R&D in the service of health, R&D for humanization of industrial life, environmental conserving and protection technologies and ecological research.

Market-Oriented Technology Promotion; Nuclear energy research (including reactor safety), coal and other fossil fuels, research and technology for land-bound transport and communications (including traffic safety), electronic components, renewable energy sources and efficient energy utilization, biotechnology, materials research, technical communications, aeronautic R&D (eg. completion of Airbus family), information processing, production engineering, application of micro-electronics; micro-peripheries physical technologies (eg. laser and thin-film) and marine technology

Primary long term R&D programs are nuclear fusion, marine and polar research, and space research. Space research received DM 1.45 billion in 1990 from the federal government. Industry expenditures on air and space sectors were some DM 2.78 billion in 1989.

TECHNOLOGY STRENGTHS

West Germany has technological strengths across a broad spectrum of industrial sectors. Key technological strengths include: automotive technologies, control and instrumentation, electrical products, optical instruments, organic primary products (including pharmaceuticals), nuclear reactors and pesticides.

KEY ORGANIZATIONS

Lead organizations in technology development are:

- *Federal Ministry for Research and Technology (BMFT)*
  This is the main government department concerned with the promotion of market-oriented technologies. It supports both "strategic basic" research and development.
- *Max Planck Gesellschaft*
  The role of the sixty Max Planck institutes is to complement the research at the scientific universities and to establish priorities in specific areas of research, particularly in basic research in the natural sciences, the social sciences and the humanities.
- *National Research Centres*
  The 13 national research centres with a budget of approximately DM 2 billion per year conduct research on tasks relating to interdisciplinary complex problems. It is anticipated that the centres, in line with government policy, will put greater emphasis in the 1990s on information technology, production engineering, handling technology, materials research and biotechnology.
- *Fraunhofer - Gesellschaft Institutes*
  The role of the 33 Fraunhofer Institutes is to promote applied research and to work closely with industry on the applications of technology to industry.

KEY SUPPORT PROGRAMS

The main support programs include:

- *Technology Transfer Advisory Services*
  There are 85 German Chambers of Industry and Commerce, which are distributed throughout Germany, and are well funded and staffed. The federal government initially provided funding to set up advisory services in six of the Chambers. Now, there are such services in 15 of the Chambers, all of which are funded by the individual Chamber members. Each service has between one and five experts who can give advice to companies directly, or help them to get advice from consultants.
- *Consultancy for Problem Solving*
  The Government will pay for a grant of up to 30 percent of the cost of a contract from a small firm to a university, government institute, or another company to solve the technological problem.
- *Canada-Germany Agreement*
  The Canada-FRG Science and Technology Agreement signed in 1971, provides an umbrella for joint R&D projects. It has an annual budget of C$200,000 for catalyzing joint activity on the German side. On the Canadian side, the Government has recently allocated more but modest resources to support Canada's bilateral agreements with European countries, including Germany.

CONDITIONS OF ACCESS

There are no specific conditions of access. However, Germans insist on a level of technological competence in their international partners. Even in licensing agreements for which they receive money, they like to be assured of the technological ability of the licensee to properly apply and use their technology.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunities for Canadians exist in all technological areas including automotive parts, ocean industries, defence, health care products, micro-electronics, pulp and paper, wood products, environmental equipment, urban transportation, agricultural equipment and telecommunications.

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3.3.1 Baden-Wuerttemberg

Baden-Wuerttemberg, one of West Germany's leading industrial states, produces 17 percent of the country's exports. The state, whose capital is Stuttgart, has a population of 9.2 million (15 percent of the total population).

The state has more than 12,000 manufacturing companies, 95 percent of which are small and medium-sized enterprises (SMEs). Some 24 percent of Germany's automotive production originates in the state; Daimler-Benz and Porsche are headquartered in Stuttgart. Some 25 percent of Germany's electronic industry output is generated in the state through such companies as Bosch, SABA and AEG-Telefunken which are headquartered in the state. Other key manufacturing sectors include high-precision mechanical parts, machine tools, optical and other scientific and control instruments.

TECHNOLOGY TRENDS

The state has the highest density of research institutes within Europe, providing 30 percent of Germany's applied research capabilities and 22 percent of its industrial research in support of the state's major industries.

Joint Industrial Research Institutes are established by a number of companies to undertake pre-commercial research. As well, technology centers have been established to serve as incubators for new high technology ventures.

TECHNOLOGY STRENGTHS

Baden-Wuerttemberg has world class technology in several areas including; "mechatronics" (the marriage of mechanical equipment with electronics), high-precision mechanics, automotive technology (eg. front-wheel drive, electronic injection systems) optical instruments (eg. microscopes, telescopes, planetariums); surgical instruments and control equipment.

KEY ORGANIZATIONS

The principal technology development organizations include:

- *Fraunhofer Gesellschaft*; 15 of the 34 institutes are in the state. Their principal areas of research are; solid-state electronics, information processing, systems technology, materials technology, environmental technology and process control.
- *Karlsruhe Nuclear Research Center*; (3,800 staff); principal areas of research are fast breeder reactors, fusion technology, nuclear fuel reprocessing and cryogenics.
- *Stuttgart and Karlsruhe Universities*; their major fields of research are micro-electronics, sensors, lasers, informatics, materials, biotechnology and antipollution technology.
- *Stuttgart Max-Planck Gesellschaft;* the major areas of research are, solid-state physics and chemistry, optoelectronics and powder metallurgy.
- *Heidelberg research complex for biotechnology*; several institutes are grouped under this rubric - eg. European Laboratory of Molecular Biology, German Cancer Research Centre, Genetic Research Centre.

KEY SUPPORT PROGRAMS

The principal technology development support program is the Industrial Promotion Program of Baden-Wuerttemberg, aimed at strengthening the international competitiveness of the state's SMEs through financial assistance, vocational training and regional development. Part of the program is to encourage technology transfer through twenty university-based technology transfer centres.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Specific opportunities exist in automotive, electronics, environmental and medical technologies. The Government of Ontario has signed a Memorandum of Understanding with the State of Baden-Wuerttemberg to facilitate contacts between companies in the two jurisdictions and the identification of specific joint projects in areas of mutual interest.

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3.4 UNITED KINGDOM (U.K.)

The U.K. has a GDP of about £390 billion (C$730 billion) and a population of some 57 million. The major industries in the U.K. are machinery and transport equipment, metals, food processing, paper and paper products, textiles, chemicals, clothing, motor vehicles, aircraft, ship building, petroleum and coal.

The U.K. spends 2.3 percent of its GDP on R&D, half of which is financed by industry. It ranks fourth or fifth in overall R&D spending worldwide.

The Government currently provides nearly £5 billion support for R&D directed principally towards procurement (47 percent), improvement of technology (18 percent) and advancement of science (17 percent). Half of the annual Government expenditure supports defence research, one quarter university research and the remaining quarter civil research (the last a gradually decreasing share).

After the United States and Japan, the U.K. is Canada's most important trading partner.

TECHNOLOGY TRENDS

As a result of recent U.K. Government reviews, the amount and balance of government supported research is being altered:

- Gradual increase in support for advancement of science activities with budgets of the five research councils for university research grants and Council Intramural Laboratory programs benefitting, although unevenly.
- Curtailment of government support for industry R&D has been curtailed, with cost-shared support generally only available for industry-led collaborative projects within the U.K. and Europe. Industry no longer receives support for "near-market" research which the government considers to be the responsibility of industry to sponsor without assistance.
- Maintenance of government assistance for technology transfer, industry-education links and expert/management support, aimed at small companies.
- Reduction of government expenditures for public sector civil R&D to a Gross Expenditure on R&D (GERD) percent level similar to what Japan and the United States spend (ie. from 25 percent in 1987 to 10 percent within the next few years). In practical terms, most government laboratories are either being closed, privatized or converted to support exclusively government policy or program mandates. Laboratories which are retained in government support roles will be quasi-independent agencies and will operate by obtaining contractual funding agreements to supply specific services to government departments.

The emergence of environmental issues has caused new resources to be devoted to research on atmospheric processes, energy and water pollution. The environmental industry sector is not as well developed as in Canada which represents a business opportunity.

Food safety is another area where public awareness and research has increased because of recent food contamination problems.

The recognized major strategic technology areas, biotechnology, materials, informatics/robotics remain high priorities especially with respect to European collaboration.

TECHNOLOGY STRENGTHS

The U.K. has broad technological strengths across most sectors, and is strengthening an already formidable science base. There are however concerns about U.K. industrial innovation and competitiveness, and ability to avoid a brain drain in the new "1992" European environment. Specific strengths include defence technology, telecommunications, aerospace, software development, pharmaceuticals and biotechnology, aquaculture and offshore oil and gas technology.

KEY ORGANIZATIONS

- *Department of Trade and Industry (DTI)*
  Encourages and supports industrial innovation and R&D. Also, through the DTI's Chief Engineer and Scientists, establishes government-wide policy, eg. on the status and operations of government laboratories/agencies. Also has major international trade responsibilities.

  DTI has five industrial research establishments which are being converted to semi-independent agencies or private sector research institutes:
  - National Engineering Laboratory (NEL)
  - National Physical Laboratory (NPL)
  - Laboratory of the Government Chemist (LGC)
  - Warren Spring Laboratory (WSL)
  - National Weights and Measurement Laboratory (NWML)

- *Research Councils*
  The five major research Councils not only support university research but also serve as important funding partners in industrially-relevant projects. In addition they have major laboratories, eg. British Antarctic Survey.

The Councils are:
- Science and Engineering Research Council
- Natural Environmental Research Council
- Agriculture and Food Research Council
- Medical Research Council
- Economic and Social Research Council
- Proposals to combine the Councils into one Super Council have been shelved.

- *British Technology Group (BTG)*
  Handles intellectual property, patenting and licensing for universities and other public sector sources, sometimes with provision of funding for technology development, transfer and exploitation. BTG ploughs back its retained share of license royalty income into the development and exploitation of other technology, and acts as a catalyst for start up companies.

SUPPORT PROGRAMS

Research related to industry is encouraged and financed through a variety of competitive programmes:

- LINK.
  Cost-sharing of joint pre-competitive research involving companies in collaboration with Higher Education Institutions and Research Councils. LINK Programmes underway include molecular electronics (five year programme, total value £20 million), Advanced Semiconductor Materials (five years, £24 million), Industrial measurement systems (five years, £22 million), Eukaryotic genetic engineering (four years, £4.6 million), Protein

Engineering (five years, £10 million), Nanotechnology (four years, £15 million), Optoelectronics (three years, £30 million) and Catalysts (five years, £5 million). About 20 programmes have been launched with an expected 500 industries participating and government contributions next year at £76 million.

- EUREKA and EEC Programs. EUREKA (launched in 1985) encourages industrially-led projects with European Community and other European partners with the U.K. participants receiving varying proportions of financial support from the U.K. Department of Trade and Industry (DTI). U.K. companies are also encouraged to obtain support from the E.C. Programmes, and are participating in many, eg. BRITE, EURAM, ESPRIT. The U.K. is contributing about £660 million to the E.C. Framework Programme (1987-91).
- ADVANCED TECHNOLOGY PROGRAMME (ATP). Collaborative research among companies supported by the DTI to promote long term research and industrial application. For instance the Information Engineering Programmes have replaced the well known Alvey Program. ATF also supports Advanced Robotics, Wealth from the Oceans, High Temperature Superconductivity, etc.
- INTERDISCIPLINARY RESEARCH CENTRES. University-based Centres of Excellence in fields such as Superconductivity (Cambridge), Molecular Sciences (Oxford), Optics and Lasers (Southampton/ University College), Surface Science (Liverpool), Process Simulation and Control (Imperial), Engineering Design (Glasgow), and Population Biology (Imperial). University Research Councils fund the Centres at a cost of £15-20 million annually.
- SMART. (Small firms Merit Award for Technology). DTI assistance for small high-tech firms to improve strategies and management.
- CLUBS, groups of companies jointly funding projects in particular areas of common interest (eg. biotransformation) with contributions from DTI.
- THE TEACHING COMPANY SCHEME assists manufacturing companies to form partnerships with higher education institutions including specialist support or placing science or engineering students in the company as well as preferred access to universities, polytechnics or the Scottish central institutions. This popular and successful scheme has proven to be an excellent mechanism for diffusing technological innovations.

Some industries are forming new research units without direct government assistance, for instance Warwick University in Coventry will house a £7 million Rover advancedtechnology centre and a £3 million Rolls Royce advanced Ceramics Centre. Of longer standing are about 24 Industry Sector Research Associations, which are exclusively supported by U.K. company members, among them the Food Research Institute and the Production Engineering Research Association. Other ancillary organizations have also sprung up to serve industry including Defence Technology Enterprises which aims partly to secure civilian applications for (Ministry of Defence) defence technologies.

CONDITIONS OF ACCESS

Any U.K. company with manufacturing and/or research facilities in the U.K. would be eligible for support if the requirements are met. Often the cost-sharing ratio is determined on a case-by-case basis. Ownership of companies is not an eligibility criterion although availability of finance from abroad (eg. from the parent organization) is an important criterion and can reduce the U.K. contribution.

Access to collaborative programs by companies outside the E.C. varies, but if a good case can be made participation is usually possible, although without eligibility for U.K. government financial incentives.

Access to laboratories is not usually restricted but is now almost exclusively on a fee for service basis, although quid pro quo arrangements are negotiable. Canadian agencies, such as the National Research Council for example, have had such arrangements.

Access to university expertise is usually negotiated through technology transfer/contract offices.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Canadian companies willing to plan carefully and invest the time and efforts to collaborate will benefit from investment and trade opportunities in such fields as ocean industries, automotive parts, telecommunications, electronics, defence industries, urban transportation, plastics/chemicals and wood products, environmental technologies, health services and medical devices, and sports facilities.

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3.5 BELGIUM

Belgium has a GDP of about BF 5,500 billion (C$180 billion) and a population of about 9.9 million (1988).

Total R&D expenditures: 1.65 percent of GDP (1987). Of this total 73 percent is performed and almost totally funded by industry.

Belgium is made up of three separate regions; Flanders in the north, Wallonia in the south and Brussels in the middle.

TECHNOLOGY TRENDS

University research activities are scattered out over many academic institutes. The inter-university poles of attraction (PAI) program is aimed at the creation of inter-university networks in fundamental research. Wallonia is setting up technology centres gravitating around universities; six centers are being proposed, covering such topics as biotechnology, informatics, robotics and new materials.

In Flanders, action is being focused on four areas, namely microelectronics, biotechnology, new materials and the environment. For each area, an integrated approach is being followed. Not only research but also education, commercialization and social factors are being considered.

A major difficulty in Belgium is to have a clear view of government policy on science and technology. In the eighties, Belgium has become a federalized country and S&T has mainly become a regional affair. Only in areas that are supra-national in character, such as space research, aeronautics (airbus), Antarctic research, the European Frame programme and bilateral agreements does the national government still have jurisdiction. All other activities have by now gone to the regions, involving the transfer of both funds and thousands of people. However, the national government still plays a coordinating role and can also initiate national programs in concert with the regions.

TECHNOLOGY STRENGTHS

The following sectors have been identified as sectors where expertise exists:

- medical technology (Institute for Tropical Medicine in Antwerp, universities)
- microelectronics (Interuniversity Microelectronic Center (KUL), many small companies)
- advanced industrial materials (universities)
- biotechnology (universities, selected companies)
- agriculture (Ghent and Gembloux universities)
- environmental equipment (selected companies)
- metallurgy and machine building (fabrimetal)
- textile technology (Centexbel)
- remote sensing (selected companies)
- food and chemicals technology (Solvay, multinationals)
- pharmaceuticals (selected Belgium and multinational companies)
- glass technology (Glaverbel, Verlipack)
- aeronautics (selected companies)

KEY ORGANIZATIONS

At the national level:

- science policy office of the national government
- the Nuclear Energy Research Centre (SCK/CEN)
- a large number of sectoral research centres, covering beer and associated products (CBM), textile (Centexbel), affiliated with the Industrial Association (Fabrimetal), transport (CRR), construction (CSTC), wood (CTIB), diamonds (CRSTID), coatings (CORI), metallurgy (CRM), welding (IBS), and the electrical industry (Laborelec).
- approximately 20 national scientific institutes, such as the agricultural centres in Ghent (CLO) and Gembloux (CRA), the Institute for Chemical Research (RC) in Brussels and the Institute for Hygiene and Epidemiology (IHE) in Brussels.

In Flanders:

- the services for science policy and technology.
- three major universities in Leuven (KUL), Ghent (RUG) and Brussels (VUB).

In Wallonia:

- L'Administration de l'Energie et des Technologies Nouvelles.
- three major universities in Louvain-la-Neuve (UCL), Liege (ULG) and Brussels (ULB).

KEY SUPPORT PROGRAMS

The IRSIA (Institute for the Encouragement of Scientific Research in Industry and Agriculture) supports industrial and agricultural research. The budget of this institute is now almost completely regionalized. The major foundations for support of scientific research in universities are also being regionalized (FNRS in Wallonia, NFWO in Flanders).

The science policy office operating under the aegis of the Minister for Science Policy and the Secretary of State for Science Policy, is responsible for, among other things, evolving the broad lines of national science policy and preparing the inter-departmental science policy budget program. Specific programs are the special fund for universities research, interuniversity attraction poles (PAI) and impulse programs such as artificial intelligence, biosciences and remote sensing. All these programs apply to academic research. On the industrial side, financial support is given to specific programs like Airbus, Space Program and the Framework Program of the European community.

The regional governments actively support technological development through loans to industry and by direct investment.

CONDITIONS OF ACCESS

No specific conditions for collaboration exist, other than the willingness and capability of Canadian firms to master and apply the new technology involved. The fact that industrial research is spread out over a larger number of companies than in the Netherlands (75 percent of industrial research is being carried out by 122 companies) should make access by smaller Canadian companies easier.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Areas where specific opportunities for collaboration with Canada most likely exist are plant genetics, chip design, specific aeronautical applications and biotechnological applications in the medical field.

Canada has a bilateral science and technology agreement with Belgium.

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3.6 ITALY

Italy, with a GDP of about L 925,000 billion (C$830 billion), spends about 1.3 percent of this amount on R&D. About 33 percent is spent by the private sector. About one percent of the labour force is employed in R&D.

Key export sectors include by order of importance; engineering products, textiles/clothing, transport equipment, metals/minerals, chemicals, food and agriculture and industrial machinery and tools. More than half of exports are to other E.C. countries.

TECHNOLOGY TRENDS

The major trends in government R&D policies are:

- Internationalization of R&D: increased support and commitment to European research programs such as EUREKA, BRITE, ESPRIT, etc. and efforts to correlate domestic programs with these in order to cut costs and duplication as well as to link up with technologically strong E.C. companies and consortia.
- Gradual increase in government allocations to industrial applied research to three percent of GDP and renewed (fiscal) incentives for contributions by private industry.
- Reorganization of state administration of R&D resources and programs through the centralization of policy and management in the Ministry of Technological Research and Universities (MRST), make MRST the sole administrator of the state R&D budget and the focal point for a cohesive Italian R&D effort coordinating all CNR (National Research Council) domestic programs, private industrial R&D, academic research and Italian public and private participation in E.C. programs.
- Institution of new state agencies (the Italian Space Agency) reporting to MRST responsible for coordinating and monitoring all private and public R&D initiatives within a given sector (space) and coordinating these with European E.C. programs (ESA).
- Increase of government grants and fiscal incentives for environmental R&D programs and for technological and industrial investment in Southern Italy.

There is total commitment by the private sector to R&D which it recognizes as critical to maintain the quality of products and remain internationally competitive.The major technological thrusts are: machining centres, automation, robotics, electrical and electronic controls; automotive sector; recycling and processing of materials; advanced materials; industrial machinery; informatics (computers etc); marble granite sector; avionics; furniture, design, manufacturing, use of new and mixed materials; food processing, packaging, canning, automation, special machinery; wood working machinery and tools; plastics, machinery and processing; petro chemical, chemical processing, fine chemicals; ceramics, processing, machines, and equipment; shoe manufacturing; textiles, fashion, machines and equipment; leather tanning and processing.

TECHNOLOGY STRENGTHS

Italy prospers in its capability to design and generate new and advanced technologies. Some major technology strengths are (key companies in brackets):

- robotics, machining centres, automation, flexible and computer integrated manufacturing (Mandelli, Rambaudi, Comau, Sapri, Duplomatic, Jobs).
- numeric controls and sensors (Marpossa, Sapri, Elam, Fiar, Comau, Mecof, Prima Industrie)
- advanced space robotics (Aeritalia, Tecnospazio, Milan and Turin Polytechnic, Pisa University)
- avionics such as landing gear, special controls, engine components (Aeritalia, Agusta, Nardi, Piaggio, Magnaghi, Fiat Aviazione)
- high efficiency titanium refining processes (Ginatta)
- plastic machinery/injection moulding (BM Biraghi, Mir, Remu, Negri and Rossi, Nuova Plastic Metal, Sandretto)
- plastic machinery/extruders (Amut, Dolci Bandera)
- plastic recycling machinery (Sorema, Bandera, FBM, Govoni, BM Biraghi)
- plastic recycling process (BG Plast, Cadauta, Reval, Sohital Comelli)
- reinforced plastic products (Azimut, Comar, Isola, Rolfo)
- film extrusion (Snia Moplefan, Manuli, Saffa, Nuova Pansac)
- automotive components and parts manufacturing (Fiat group owns practically all car production/brands in Italy and owns/controls major part of suppliers. Some of the major components and parts importers are Valeo, Redaelli, Hella)
- furniture design and automated manufacturing (B and B, Cassina, Scavolini, Molteni, Fantoni, Snaidero)
- wood working machinery (SCM, Stefani, Celaschi, DMC, Cremona)
- petrochemical/chemicals (Enimont, Snamprogetti, Ferruzzi Group)
- marble granite cutting machinery and tools (Breton, Terzago, Gregori, Pedrini, Simec)
- ceramics (tiles) manufacturing technologies (Marazzi, Iris)
- textiles, machines, tools and accessories
- food processing, packaging, canning, automation, special machinery (Rossi, CIM Exports, Gruppo TAU, Ilva Spa, Pavan, Manzini, Comaco Spa)
- leather tanning and processing (Cogolo, Cortan).

KEY ORGANIZATIONS

Key public sector technology development organizations include the National Research Council (CNR), the National Commission for Nuclear and Alternative Energy Sources (ENEA), the National Electric Energy Corporation (ENEL), the Institute for Industrial Reconstruction (IRI), the National Hydrocarbons Corporation (ENI), the Manufacturing Industry Shareholdings and Financing Corporation (EFIM), the Experimental Institute of the Italian Railway, the Superior Institute of the Post and Telecommunications Department, and the Italian Agency for Air Navigation Services. All of these agencies offer potential for technology transfer and cooperation.

In addition there are industrial organizations such as the CECCP of Turin, Foreign Centre of Piedmont Chamber of Commerce, which help to locate and transfer technologies; the Cestec in Milan with its mandate to help SMEs with their operational problems, technology development; the UCIMU (technology transfer division) which is an association of major manufacturers of machine tools and automation; they also help in development of new technologies; and the polytechnics of Turin, Milan, and Pisa.

The patent office in Rome is responsible in issuing patents. In the private sector licensing of technologies is undertaken by companies using legal services. Lately however, major Italian banks have increasingly become interested in arranging for technology transfer and venture capital.

KEY SUPPORT PROGRAMS

Financial support provided by the Italian state to research is available from different sources. Specific funds have been established for applied research and for technological innovations. Financing, often taking the form of generous grants, is also available under regional development programs, especially those aimed at the south of Italy.

Italy has also invested both money and scientific expertise in collective research. It is third, after West Germany, in terms of participation in the European collective research effort. An example of this collective effort is the Common Research Centre, where multiple research initiatives are aimed at increasing European competitiveness in avant-garde industrial technologies. Today, there are four such centres throughout Europe. However, the original and still the largest centre was founded by the Italian government when it transferred ownership of the Ispra Centre for Nuclear Studies to EURATOM. Italy is also one of the main thrusts behind European research programs such as EUREKA, ESPRIT, RACE, BRITE, EURAM, BAP, and JET.

CONDITIONS OF ACCESS

There are no known specific conditions which apply to foreign firms and research organizations wishing to collaborate with Italian firms. In licensing, companies come to mutual agreement often using legal assistance. Where patents are involved arrangements become more complex.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Key areas of technology opportunities are: machine, tools, automation, flexible manufacturing, biotechnology, artificial intelligence, opto-electronics, plastics machinery and process, robotics, controls and sensors, ceramics, food processing, packaging, special machine and tools, wood working machinery, leather tanning and processing, furniture design and manufacturing, new materials and composites, industrial design, glass, textiles, and dimension stone processing.

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3.6.1 Lombardy

Lombardy, Italy's fourth largest region whose main centre is Milan, accounts for close to a quarter of the country's industrial production. The region accounts for one third of the active corporations in Italy, import-export volume and foreign investments. This is due to the high productivity of capital invested in the region, where about 21 percent of the gross national product is generated with a share of investments slightly over 17 percent.

The labour force in Lombardy is about 3,678,000 which is equal to 41 percent of the region's population and about 18 percent of the total national labour force. Industry employs 1,626,000 of which 1,295,000 work in manufacturing. Some 45 percent of the region's labour force lives in the Province of Milan.

Lombardy accounts for about 31 percent of Italian outlays for R&D state companies, while for privately owned firms the figure nears 40 percent.

We find installed in Lombardy 31.4 percent of the largest main frame computers while Milan alone accounts for 25 percent of the data processing centres, 10 percent of the industrial robots and 15 percent of the CAD/CAM systems operating in the country.

Milan can also boast of the highest concentration of private and public post graduate educational centres as well as the major non university research centres such as Cise (applied physics) Mario Negri Institute (pharmaceutical and biology) Assoreni (chemistry, applied engineering) IRB (new materials) ISMES (civil engineering) and Donegani Institute (chemicals), ISPRA (EC - designated research centre for nuclear energy).

TECHNOLOGY TRENDS/STRENGTHS

The Lombardy region has a presence in all the product areas and in all industries. There is a greater concentration than the national average in the high value added industries such as metalworking, petrochemical, plastics, papermaking (see Italy Section 3.6).

KEY ORGANIZATIONS/SUPPORT PROGRAMS

- as per Italy Section 3.6

CONDITIONS OF ACCESS

- as per Italy Section 3.6

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

- as per Italy Section 3.6

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3.7 AUSTRIA

In 1988, Austria has a GDP of about 1,720 billion Schillings (C$167 billion) and a population of 7.6 million. R&D expenditures were about 1.3 percent of GDP. ● ●

The main industries are food and beverage, machinery and metal construction, metal products, electronics and chemical, pulp and paper, woodworking, textile and clothing.

The main economic centre is the Vienna area followed by Linz and Graz (approximately 200 kilometres away from Vienna). Smaller centres are Salzburg and Innsbruck, even further away.

TECHNOLOGY TRENDS

Areas given specific government support are electronics, new material technology, and to a minor extent biotechnology and environmental technology.

Austria participates in many international research activities, EUREKA programs. Environment technology is becoming more and more important.

TECHNOLOGY STRENGTHS

As a small but highly industrialized country (almost 50 percent of local exports go to Germany and Switzerland) the local industry specializes in very small sectors of the total spectrum.

Areas of strength are mainly concentrated in:

- machine industry (machine tools, flexible manufacturing)
- transport material handling
- measuring and control technology
- construction technology
- forest, woodworking machines and equipment
- (alcoholic and non-alcoholic beverages, milk products, fruits and vegetables, meat, sweets and bakery)
- environment technology.

KEY ORGANIZATIONS

Technologies are developed at company and university levels. There are no key developers for technology. Places with several research labs are Seibersdorf with approximately 300 scientists and Arsenal which is smaller. Some larger companies like Alcatel and Benda have set up special research labs outside the company for artificialintelligence, respective gene technology. The Austrian nationalized industry is supporting a number of research labs in particular disciplines.

So-called technology parks support young companies starting with new technologies. An organization supporting the exchange of technology internationally is the Federal Economic Chamber, Wiedner Hauptstrasse 63, A-1045 Vienna, Technology Section Dr. Wilfrid Mayr. Phone: (222) 501 05, Telex: 111871.

KEY SUPPORT PROGRAMS

Three key programs are:

- FFF, Forschungs Forderungs Fond (Research Support Fund) supporting research in companies to 50 percent of costs;
- ITF; Innovation Technology Fund (for companies);
- FFWF; Fond zur Forderung der Wissenschaftlichen Forschung (fund to support scientific research) at universities and similar organizations.

CONDITIONS OF ACCESS

Austrians are usually very open when showing their technology in order to find partners or buyers. Normal business relations are perfectly suitable to establish technology transfer or joint research agreements. Austrians do also expect that appropriate Canadian government organizations supporting Canadian partners in joint research projects would do everything possible to support Canadian companies in their part as promised, even if budget cuts make it difficult.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

There is no problem in obtaining technology if it is available. Key areas are the ones mentioned under "Technology Strengths".

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3.8 SWITZERLAND

Switzerland spends about 2.9 percent of its GDP of over SF 290 billion (C$226 billion) on R&D. Some 80 percent is financed by industry.

The country's traditional industrial strengths are in chemicals, precision instruments, food, machinery, jewellery and watches and heavy engineering.

TECHNOLOGY TRENDS

The main fields of technology development activity are:

- chemicals and pharmaceuticals, especially biotechnology applications;
- aerospace, especially in opto-electronic observation, information technology, materials science;
- information technology, especially in networks, propagation and new materials;
- energy especially in newer fields such as solar and geothermal energy;
- environmental protection; and
- microelectronics.

TECHNOLOGY STRENGTHS

Strengths lie in traditional areas such as precision instruments, chemicals, pharmaceuticals, engineering products and agri-food industries.

KEY ORGANIZATIONS

Key technology development takes place in the private sector which accounts for 80 percent of the country's R&D expenditures. Government organizations with a mandate to support industry include:

- *The Commission for the Promotion of Scientific Research (CERS)* which encourages contacts between higher education facilities and industries. This grant giving body contributes up to 50 percent of the cost of a project. The focus of activity is on materials, processes and robotics manufacturing. The CERS also assesses EUREKA and RACE projects.
- *The Swiss Centre for Electronics and Microtechnology (CSEM)* in Neuchatel, supports the electronics and precision instruments industries through joint university/industry projects. The main areas of activity are microelectronics, opto-electronics, sensor technology, micro-engineering and materials technology).
- CERN (European Laboratory for particle physics) funded by 14 countries and located in Geneva employs 3,400
- Paul Scherrer Institute targets reactor, nuclear and materials research
- Federal Institutes of Technology - largest centres are in Zurich and Lausanne and work jointly with industry (eg. informatics, machinery).

KEY SUPPORT PROGRAMS

Swiss National Science Foundation is responsible for the allocation of 17 percent of federal government research funds. The federal office for Education and Science coordinates and implements R&D policy and is developing two new programs on informatics and biotechnology. Support is also available through the key research institutes of which there are many.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunities exist in plastics/chemicals, flexible manufacturing systems, electronics, precision instruments, food, hydraulics, opto-electronics, and informatics.

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DMCN CH)

3.9 DENMARK

Denmark, with a population of 5.1 million and a GDP of about DKR 690 billion (C$125 billion), has broadened its economic base from agricultural products and beers to include machinery, electronics, food technology and pharmaceuticals.

In the period 1982-86, industrial investment increased 79 percent, industrial employment was up 13 percent, and industrial exports increased 41 percent. Denmark spends approximately 1.4 percent of GDP on R&D.

TECHNOLOGY STRENGTHS

Key technology areas listed below include companies which are highly recognized internationally.

- Agriculture and food technology
  companies: Danisco, MD Foods, Tulip, Meat Research Inst.
- Biotechnology (Particularly within agri-food sector)
  companies: Carlsberg, Novo-Nordisk, Chr. Hansen Lab., Danisco, Dakopatts
- Medical products/Pharmaceuticals
  companies: Novo-Nordisk, DAK, Loeven, Lundbeck, Ferrosan
- Health care products/ Handicap aids
  companies: Coloplast, Ambu, Danish Health Care Systems
- Electronics/Medical electronics (Often niche-oriented and based on advanced transducer technology)
  companies: Radiometer, Bruel & Kjaer, Oticon, Widex, Simonsen & Weel, Foss Electric
- Ships and harbours
  companies: Maersk, Cowi, Carlk Bro, Ramboll & Hannemann, Danish Hydraulic Inst., Welding Inst.
- Process regulation
  companies: Danfoss, S.T. Lyngsoe
- Energy technology
  companies: I. Druger, Cowi, Haldor Topsoe
- Waste management technology including hazardous waste
  companies: Kommune Kemi, Chemcontrol
- Agriculture machinery
  companies: Dania, Taarup
- Cement industry and machinery (Turn-key installations)
  company: F.L. Smith recognized world leader

KEY ORGANIZATIONS

These include:

- *National Agency of Industry and Trade*
  Responsible for administration of national technology-related schemes and programs, regional development programs, export development programs and trade regulations.
- *Academy of Technical Sciences*
  Established 1937 as an independent institution to promote technical and scientific research for the benefit of trade and industry. Among the 20 non-profit institutes affiliated with the Academy are Danish Research Centre for Applied Electronics, Danish Welding Institute, Danish Institute of Biomedical Engineering and Danish Hydraulic Institute.
- *Risoe National Laboratory*
  Largest national research institute in Denmark. Has high international representation among researchers. Priority areas: applied and basic research within energy, materials science, chemistry and biology.

- *Danish Technological Institute*
  Largest approved technological service institute in Denmark. Institute is polytechnological in character and covers wide technical and industrial spectrum. Employs a total of 1,100 technical staff. Special department for innovations, patents and licensing of new technology. A special role in information supply is fulfilled by 15 regional Technological Information Centers (TICs) administered by the Institute. The Institute has close international relations and is involved in large number of E.C. projects. Has close connections to Canadian wood research.
- *Patent Directorate*
  Responsible for patents, copy rights and trade marks. Of a total of 7,346 patent applications in 1988, 36 percent came from the remaining E.C., 25 percent from the United States and Canada, and 16 percent from Denmark.

KEY SUPPORT PROGRAMS

Danish research and technology rely on wide international cooperation. About five percent of the national R&D resources are attributed to participation in international cooperation, including the E.C. R&D programs. Participation in Nordic research cooperation is of importance to Denmark.

Denmark participates in approximately 120 E.C. programs. Among the largest are BRITE/EURAM, COMETT, ECLAIR, ESPRIT, FAR, FLAIR, JOULE, MAST, MONITOR, RACE and SPRINT. The resources of the Danish national support programs include DKR 1.1 billion of which 50 percent is attributed to technological infrastructure (eg. innovation services through European network). EUREKA: Danish firms currently participate in 35 projects.

CONDITIONS OF ACCESS

Danish companies and research institutes are open to collaboration with Canadian firms on equal terms and under normal commercial conditions. Foreign companies may participate as partners with Danish companies in government support programs (eg. industrial network program). There are no restrictions in licensing of technology to Canadian companies except in cases where an invention has been financed wholly or in part by government funds. Only in such cases would a license be offered to Danish companies on a first refusal basis.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Danish industry consists basically of smaller firms which are well aware of the essential need to export, and exports have been lead factor in the development of niche production to overcome foreign competition. Denmark's peculiar position as gateway between Scandinavia and the E.C. has furthered awareness of world market needs. Although a great part of the business community is oriented mainly towards the E.C. and the Nordic countries, Danish firms and research organizations would welcome bilateral collaboration with Canadian counterparts. Technological opportunities exist within the key technology areas such as agri-food technology, fish processing, biotechnology, medical devices, pharmaceuticals, environmental technology and agricultural equipment. Costs to Danish firms often prohibit satisfactory North American marketing efforts making them ideal candidates for technology transfer.

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3.10 NORWAY

Norway has a population of 4.2 million and a GDP of about NOK 47 billion (C$84 billion). It invests approximately 1.8 percent of its GDP on R&D.

Norway has a relatively large resource-based industrial structure including such sectors as offshore petroleum, mining, ocean transport, shipbuilding, steel production and fish processing. These sectors are the basis for exports which account for 36 percent of GDP.

TECHNOLOGY TRENDS

The government has chosen the following eight priority areas (two-thirds of total R&D expenditure falls within these priority areas):

- Information technology
- Biotechnology
- Aquaculture
- Material technology
- Oil and gas technology
- Organization, management and administration
- Traditional and cultural dissemination
- Health, environment and living conditions

A re-evaluation of the R&D system is presently taking place in Norway. There is a general feeling that R&D expenditures have not given the expected results. Too many government agencies have been giving out funds and there has not been enough coordination of these funds. It is expected that in future more R&D funds will be given to industry and less to research institutions directly. Thus industry will have more influence on how and where research funds will be used. In an effort to improve internationalization of Norwegian industry, the government will also emphasize marketing, or commercialization, of research development abroad.

TECHNOLOGY STRENGTHS

Key technological strengths in Norway are in the following areas:

- power generation - engineering, construction, production and installation of power generation stations, units and equipment (hydro power turbines, generators, transformers, cables, switchgear products) including underground installations, electrical transmission and distribution systems Firms: EB, Kvaerner, Norconsult
- metals and electro-chemicals - ferro-silicon, silicon metal, carbides, magnesium, aluminium, zinc, metal, iron and steel products. Sale of know-how, engineering expertise and advanced processing equipment to electro-metallurgical industry
  Firms: Elkem, Norsk Hydro
- chemicals - fertilizers, explosives, petrochemicals (ethylene, propylene, vinyl chloride monomer and PVC), paints and synthetic resins, edible fats and their derivatives, wood and fine chemicals, pharmaceuticals, diagnostic agents such as X-ray contract media
  Firms: Norsk Hydro, Dyno Industrier, Jotun, Nycomed
- pulp, paper and board - newsprint, magazine paper, kraft paper, packaging grades, wood-free printing and writing qualities, board, tissue, sulphite paper and greaseproof, increased use of re-cycled paper

- fishing and food - traditional fishing (cod, saithe, herring, mackerel, prawns, haddock, tusk, ling, halibut, red fish, capeline, sprat, squid, blue whiting, sandeel, pout) and fishfarming (salmon, trout, halibut, cod, turbot, lobster, plaice, oysters, blue mussels). Related technology and equipment such as fishing vessels, fishing gear, processing plants, transportation systems. Other food exports include cheese and crispbreads, beers, special spirits
  Firms: Trio Industrier, Marenor, Akvaplan, Austevoll, Mustad, Norwinch, Rapp, Morenot, Simrad; Frinonor, Seanor, Kavli, Norway Foods, Ringnes, Vinmonopolet
- shipping - shipowners (cruise operations, gas and chemical shipping, car carriers, high speed ferries, tankers and paper carriers, rigs and supply vessels to offshore industry), shipping operations (shipbrokers, insurance companies, financial institutions and research institutions) and manufacturing of specialized vessels and ship's gear
  Firms: Wilh. Wilhelmsen, Star Shipping, Olsen, Jebsen, Oddfjell, Hoegh; HMV, Fjellstrand, Frank Mohn
- engineering industries - electrical power equipment, electronic products, non-electrical machinery, offshore structures, ships (fishing vessels, high-speed passenger ships) and ships' gear (electrical and electronic products, steering, propulsion and deck machinery), metalware, foundry products, care components (wheel rims in light metals, starter batteries, fittings, plastic products, chassis, bumpers in aluminium, plastic and rubber, and cast and forged products, brakes, exhausts, car heaters, cabling, safety products), bicycles, transportation equipment. Electronic engineering include: a) telecommunications (automatic switching gear, private and public branch exchanges, multiplex equipment, radio links, satellite communications equipment) b) power network communication systems (fibre optic cables, microwave radio links, high performance antennas, satellite ground stations) c) control, alarm and monitoring systems d) office automation (mini and microwave computers, peripherals, advanced software). Consulting engineering for construction hydro power station, fish farms, offshore developments, environmental protection, water supplies, tunnelling.
  Firms: EB, SI, Fjellanger-Wideroe, Kongsberg, Norsk Data, Oceanor, Raufoss, Sintef, Selmer-Furuholmen, NGI, Norconsult, Aker, Puritech, Dbs
- design products - ergonomic furniture, interior furnishings, textiles and clothing, glassware, hollowware, cutlery, electronics, building products, winter sports gear, pleasure craft
  Firms: Dale, Helly-Hansen, Protan, Draco, Rybo, Stal og Stil, Stokke, Hadeland

KEY ORGANIZATIONS

Principal technology development organizations include:

- *NTNF - Royal Norwegian Council for Scientific and Industrial Research,* which allocates funds to institutions, companies and research projects. It is the main government arm in Norwegian research community, reports to Royal Ministry of Industry and decides the direction of the main research thrusts.
- *NAVF - Norwegian Research Council for Science and the Humanities* conducts basic research, fundamental technology development
- *Industrifondet* finances R&D projects which are less risky than what NTNF will finance

There is no specific organization responsible for licensing or patents. Legislated regulations apply to all companies. Both NTNF and Industrifondet do work related to patents and licenses.

KEY SUPPORT PROGRAMS

International cooperation projects in R&D are integrated into existing research programs in Norway, eg. the Eureka projects are integrated into the various divisions in NTNF.

Several NTNF Research Programs invite foreign participation. Those projects receiving over NOK 100 million in financing are as follows; (in brackets are desired percent of foreign participation):

A) Computer Integrated Manufacturing - NOK 189 million Production technology project (30 percent)

B) Information Technology in the Health Sector - NOK 172 million Information technology project (20 percent)

C) Production Installations for Salmon - NOK 152 million Aquaculture project (30 percent)

D) Drilling Technology - NOK 130 million Offshore technology project (10 percent)

E) Light Metals - NOK 116 million Materials technology project (7-9 percent)

F) Geographic Information Technology - NOK 112 million Information technology project (10-20 percent)

G) Security and Reliability of Information Processing Systems - NOK 111 million Information technology project (63 percent)

H) Business Growth through New Technology - NOK 103.8 million Manufacturing technology project (five percent)

I) Innovation and the Spread of Technology in North Norway - NOK 103.7 million Manufacturing technology project

Canada and Norway have two Memorandums of Understanding and an exchange of letters on scientific and technological cooperation.

CONDITIONS OF ACCESS

There are no restrictions for Canadian firms in obtaining technology.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

There are major opportunities in aquaculture, oil and gas, environmental technology, materials technology and ocean industries.

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3.11 SWEDEN

Sweden, with a population of approximately 8.5 million and an area of 487,000 square kilometres, invests about three percent of its GDP in technical and scientific R&D. The Swedish corporate sector accounts for more than 60 percent of this R&D expenditure. Unlike the other Nordic countries, defence R&D expenditures play an important role in Sweden. Sweden has been enjoying a positive balance of payments in technology in recent years although its growth in GDP (2.5 percent) has been slightly less than the average for the countries of the Organization for Economic Cooperation and Development (OECD) countries (3.3 percent in 1986). In 1986 machinery and equipment exports accounted for 52 percent of total Swedish exports.

TECHNOLOGY TRENDS

The 1990 government R&D bill for the following three years aims at raising the country's productive capacity, improve living conditions and enhance quality of life. The main emphasis is on increased resources for basic research which is predominantly done in universities. Strong emphasis is also put on international co-operation, essentially through participation in EUREKA and E.C. projects. Priority areas are the environment and new materials technology (in addition to earlier programs in biotechnology and information technology). Private industry will continue to spend R&D money in the areas of telecommunications, mechanical engineering, biomedical technology, energy technology and pulp and paper processes.

TECHNOLOGY STRENGTHS

World class strength in technology is found in multinational corporations and is not normally available for licensing (eg. high voltage transmission, industrial robots, small scale nuclear reactors by Asea-Brown Boveri (ABB); radar, telecom switching, mobile radio by Ericsson; car safety design, regeneration bus propulsion by Volvo; non friction movements and bearings by SKF; air treatment technology by Flakt).

In addition, there is advanced and proven technology available through small and medium sized companies, especially in forest products, energy efficiency, defence systems and transportation related technology.

KEY ORGANIZATIONS

The principal technology development institutions are:

- *Swedish National Board for Technical Development (STU)* - Stockholm; The government's central mechanism for providing support for technical research and industrial development, STU with an annual budget of about C $130 million:
  - initiates, coordinates and supports technical research and development at universities and cooperative research institutes;
  - cooperates with universities and industry to develop and speed the introduction of new technology;
  - stimulates and supports inventors, small-medium sized companies and newly-established technology companies with product renewal.

STU in cooperation with Swedish companies is financing, over a three year period (SEK $55.5 billion), in such areas as computer science, digital communications, computerized image technology, operation development systems for the processing industry, technology for the handicapped, and civil-aviation research.

- *The Royal Swedish Academy of Engineering Sciences (IVA) - Stockholm*; The IVA is a learned society whose aim is to "promote engineering sciences and industry for the benefit of society". In 1988 its budget was C $9.5 million. IVA conducts studies and analyses of technological issues and their impact on modern society and industry. IVA also acts as a forum for international contacts for the exchange of specialists and information on R&D, and for the establishment of technical and industrial collaboration.
- *The National Industrial Board (SIND)*; SIND operates under the Department of Industry, and manages a system of regional development funds set up in each of the 24 Swedish counties. A main objective of these funds is to finance industrial innovation especially in the latter stages of the innovation process (ie. pilot plant, test production, market evaluation).
- *The National Defence Research Institute (FOA)*; this institute publishes a large number of unclassified reports every year.
- *The Council for Building Research (BFR)*: this organization publishes numerous reports on construction technology.

A number of co-operative research institutes in most industrial sectors do research for the private sector. These include the Swedish Wood Technology Institute, the Swedish Pulp and Paper Laboratories, the Swedish Institute of Production Engineering and the Swedish Packaging Research Institute.

KEY SUPPORT PROGRAMS

Although R&D funding comes from several government bodies, STU delivers the principal technology related support programs. Product development support is similar to the Canadian National Research Council IRAP program. For larger industrial high risk projects, the Swedish Industrial Fund can provide evaluation and financing.

STU also administers national R&D programs with private industry participation and cost sharing in the final phase. Examples are the microelectronics program and the information technology program. Industry participants were Abb, Ericsson, Nobel Industries, Saab Scania and Teli.

CONDITIONS OF ACCESS

Except for normal considerations of confidentiality and propriety rights, foreign involvement is treated from a business point of view of cost, benefit and risk.

Swedish industry's strategy for expansion is to internationalize, a process taking place rapidly through acquisitions, partnerships and industrial cooperation.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Areas of interest to Canadians are; pulp and paper (new processes, energy savings, recycling); forestry (reforestation, forest management, harvesting); wood (optimization, sawing, drying, components, automation); mechanical (automated materials handling); energy (solid fuel combustion, industrial heat pumps, district heating); environment (solvents, aerobic water treatment, energy production from household waste, catalytic converters).

By offering access to the North American market, Canadian companies will find significant opportunities on technology transfer and industrial cooperation.

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3.12 FINLAND

Finland has a population of 4.9 million and a GDP of FIM 440 billion (C$126 billion).

Key industrial sectors include metal products and engineering, pulp and paper, and chemicals. About one third of the GDP is exported.

In 1989 Finland spent 1.9 percent of its GDP on R&D. Industry contributes more than 60 percent of this expenditure.

TECHNOLOGY TRENDS

Finland's technological and industrial policies aim especially at:

- maintaining the competitiveness of the country's basic industries (eg. wood processing and metal) and
- creating new industries in emerging sectors of technology (eg. information technology, biotechnology).

The following national technological programs, initiated by the Technology Development Centre (TEKES), have planned total annual budget expenditures of greater than FIM 40 million:

- Information technology program (FINPRIT)
- Microelectronics program
- Functional paper
- Industrial building technology
- Software technology (FINSOFT)
- Biotechnology
- Powder metallurgy products
- Forest products technology

In 1989, the Finnish Ministry of Trade and Industry initiated a three-year project called, "Managing Technological Change (MTC)" to assist in the internationalization of Finnish firms. The aim of the MTC project is to invite top foreign experts to Finland to advise companies and to lecture at universities.

Finland has a network of seven science parks located throughout the country, and three technology oriented universities: Helsinki University of Technology, the Tampere University of Technology and the Tapeenronta University of Technology.

There is a concerted push to expand international cooperation through E.C. technology programs, EUREKA, associate membership in ESA.

TECHNOLOGY STRENGTHS

Finland has traditionally been strong in wood processing technology (research institutes include Central Laboratory, Technical University Wood Processing Laboratories and ABO Akademias Wood Processing Department in Turku. Further research is carried out at Oulu University Process Technology Department, Tampere Technical University Plastics Technology Institute and the Lappeenranta Technical University Process Technology Department

Other strengths include metallurgy (research institutes include Technical University Metallurgy Department, Technical Research Centre of Finland's Technical Metallurgy and Minerals), chemistry (Technical University Chemistry Department, Abo Akademias Chemistry Department, Oensuu University Physical Chemistry Department, Oulu University Process Technology Department, Tampere University Chemistry Department). Technological strengths also exist in microelectronics and telecommunications.

KEY ORGANIZATIONS

Principal technology development organizations include:

- *The Technology Development Centre (TEKES)* Reporting to the Ministry of Trade and Industry, TEKES, headquartered in Helsinki, coordinates international cooperation in technology and assists in raising the standard of technology in Finland through the management of national technological programs that link Finnish industry with research institutions. TEKES provides grants and loans for information technology centres, science parks, industrial R&D, and applied technological research. Its budget in 1988 was FIM 532 million.
- *The Technical Research Centre of Finland (VTT)* Finland's largest research institute, VTT consists of five research divisions comprising over 30 laboratories and a staff of approximately 3000. The objectives of VTT are to maintain and improve the general level of technology in fields of national importance, and to meet public and private clients' demands for research and testing. It meets these objectives through R&D in five areas:
  - energy and its safe, domestic production
  - extensive exploitation of information technology in products and production
  - advances in the process industry and in the use of domestic raw materials (including research in microbiology)
  - application of building technology in areas such as materials, heating and plumbing, and fire safety
  - manufacturing technology and production methods throughout the mining/metal and machinery/engineering industries
- *The Finnish Pulp and Paper Research Institute* A private corporation owned with a staff of 300 by Finnish paper companies, it is the central research institute of the pulp, paper and paperboard industry in Finland. Research activities within the Institute are divided into four sections: by-products, pulping processes, paper and board, and technical services.

KEY SUPPORT PROGRAMS

International technology development programs coordinated by the Technology Research Centre are:

- microelectronics (1987-1990)
- software technology (Finsoft) (1988-1992)
- mechatronics (1987-1989)
- polymer matrix composites (1988-1991)
- powder metallurgy products (1986-1990)
- metal working and forming technology (1985-1989)
- functional paper technology (1977-1991)
- biotechnology (1988-1992)
- pharmaceutical technology (1989-1993)
- Arctic technology (1985-1989)
- industrial building technology (1986-1991)

CONDITIONS OF ACCESS

Any foreign company or research institute can arrange cooperation on a project level. Firms which have manufacturing in Finland can participate in above technology programs.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Major opportunities exist in the pulp and paper, resource development equipment, wood products and agricultural equipment.

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3.13 NETHERLANDS

The Netherlands has a GDP of about 440 billion Guilders (C$270 billion) and a population of 15 million. R&D expenditures amount to 2.3 percent of GDP. Of this total, 61 percent is performed in and mostly paid for by industry. Some 63,500 people, that is more than one percent of the working population, are involved in R&D. ● ●

The principal Dutch exports are machinery and transport equipment, food, drink and tobacco, chemicals and plastics. Over 70 percent of exports go to the E.C.

TECHNOLOGY TRENDS

More attention is being focused on environmental technology. A national Environmental Technology Program (NPM) will start in 1990 and there are more and more environmental projects within EUREKA.

There is increased internationalization of science and technology, but with strong emphasis on Europe and continuing strong participation in EUREKA. The Netherlands, through Philips, will play a key role in the joint European Submicron Silicon Initiative (JESSI) aimed at developing European submicron chip technology.

Increased emphasis is being placed on technology diffusion and small firms. There are now 18 innovation centres scattered over the country and each university has its transfer point.

TECHNOLOGY STRENGTHS

The following have been identified as strong sectors:

- health care and medical technology; TNO, universities
- microelectronics; Philips, Holland Elektronika, Centres for Microelectronics at the three technical universities
- new and advanced industrial materials; TNO, universities, selected companies
- ocean related science and technology; Marin, WL, universities, Ministry of Transport
- geosciences; GD, universities
- biology and biotechnology; universities, selected companies
- agriculture and tropical forestry; agricultural university, Ministry of Agriculture
- environmental technology and equipment; Federation of Suppliers of Environmental Services and Technologies (FMPS)

KEY ORGANIZATIONS

The Ministry of Economic Affairs is responsible for stimulating development of new industrial technology.

IOTSP (implementing organization for technology stimulation programmes) is a semi-governmental organization responsible for implementing technological innovation. Stipt is also responsible for the EUREKA programme.

The Ministry of Education and Science is responsible for scientific research, mainly within the university and scientific institutes.

TNO (Netherlands organization for applied scientific research) is now theoretically an independent research organization, with considerable infusion of government money in various forms. It covers a wide range of scientific and technological activities.

Other major technological institutes are ECN (energy research), GD (soil mechanics), Marin (maritime research), NLR (aerospace laboratory), and WL (hydraulics laboratory). Three technical universities, an agricultural university and most of the other nine universities have active science and technology programmes. The Octrooiraad or patent office is mainly responsible for issuing patents in the Netherlands.

KEY SUPPORT PROGRAMS

The following programs are aimed at the stimulation of industrial development. The newly formed Stipt organization will implement these programs at arm's length from other government departments; the Innovation Stimulation Scheme (INSTIR), which was renewed in 1989; the Technical Development Credit (TOK); the Business Oriented Technology Stimulation Program (PBTS), which constitutes the nucleus of national technology programs on materials, biotechnology, medical technology and information technology; a fifth program on environmental technology will start in 1990; the Innovation Directed Research Programs (IOP) are in support of research in universities and research institutes. A number of IOP's in such areas as materials, biotechnology, catalysis and carbohydrates are under way. An IOP on environmental technology is in preparation.

The Business Oriented Stimulation of Technology in International Programs (BTIP) scheme was started in 1980 in support of international projects such as EUREKA.

CONDITIONS OF ACCESS

No specific conditions for collaboration, obtaining licences or other forms of technology transfer exist, other than the willingness and capability of Canadian firms to master and apply the new technology involved. Also one should realize that 85 percent of all industrial research in the Netherlands is being carried out by only 20 large companies. Hence most industrial technology would be owned by large companies.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Biotechnology is an area where active cooperation is being pursued through a pilot plant project. Advanced industrial materials and the environment would appear to be the most suitable areas where further cooperation should be tried. As well, there are possibilities for joint projects in telecommunications, language and image processing, new production systems, transportation and logistics systems.

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3.14 SPAIN

Spain is the second largest country in Western Europe whose major urban areas are Madrid, Barcelona, Valencia, Sevilla and Bilbao. GDP has been growing at five percent per annum in real terms. The population is 38,996,000. Key industrial sectors are automotive, capital equipment, steelmaking, mining, food processing, electric power, electronics and computers, engineering and construction, petrochemicals and textiles.

In 1988, expenditures on R&D were 0.8 percent of GDP. The Spanish government is aiming at an increase in R&D equivalent to 0.1 percent of GNP annually in order to reach a total of 1.2 percent of GNP in 1991. Distribution of expenditure by type of research is approximately as follows: 20 percent on basic research; 35 percent on applied research and 45 percent on technological development.

TECHNOLOGY TRENDS/STRENGTHS

In 1987, the Spanish government announced the first national plan for scientific research and technological development (1988-1991). The Spanish government targets under the plan are implemented by means of national programs which interact with the sectoral and regional programs. Priority areas are:

- Horizontal Programs: Training of R&D Staff, interconnection of information networks, communications and production technologies, micro-electronics, new materials, robotics, information and communication technologies, space.
- Natural Resources, Agricultural and Food Technologies: agriculture, stockbreeding, aquaculture and marine resources, geological resources, food technologies, environmental, forest systems and their preservation.
- Quality of Life: biotechnology, health, pharmaceutical research, social aspects of science and technology, special programs, high energy physics.

KEY ORGANIZATIONS

These include:

- *The General Secretariat of the R&D National Plan.* Its objectives are: coordination of the programs and activities of the National Plan, technical and budgetary management; administration of the plan. It is also responsible for monitoring and coordinating the initial R&D programs in which Spain participates. It collaborates with the Spanish organizations involved in scientific cooperation with other countries and coordinates Spanish participation in important European research programs.
- *The Spanish Council for Scientific Research (CSIC)* - the CSIC defines its scientific objectives in accordance with state scientific policy. Sectoral priorities in the economic, social and cultural fields, and the results of scientific survey. CSIC pursues these objectives through a series of very diverse means: the creation of research centres, of joint centres with universities and other bodies, and of centres that are governed by a board on which other branches of the government administration are represented.

The CSIC's resources are: 80 institutes; 5,800 members of staff; 1,700 scientists; 3,700 technicians, assistants and office personnel; 250 post-doctoral fellows; 600 post-graduate students.

- *The Centre for Industrial Technological Development (CDTI)* - The CDTI is a state company entrusted with the implementation and development of the industrial innovation policy defined by the General Secretariat of Industrial Promotion and Technology (Ministry of Industry and Energy). The CDTI's functions are as follows:
- the identification of priority fields of technology;
- the promotion of industrial utilization of the technologies developed, financial assistance for pre-production manufacture and the marketing of new products and processes;
- the granting of loans on favourable terms for the financing of technological development projects;
- cooperation with the interministerial Commission for Science and Technology in securing scientific, technological and industrial feedback from international programs in which Spain is participating.
- And the management of the programs for which the CDTI is responsible: EUREKA, ESA, Airbus and ERN and shares responsibilities for several European Community programs: ESPRIT, BRITE/EURAM, DELTA, RACE, AIM, BRIDGE, ECLAIR, FLAIR, new materials and recycling.

The CDTI funds two types of projects:
- Technology development or innovation projects; and
- Concerted projects

These are captured in the national and regional programs.

CONDITIONS OF ACCESS

Spain is a member of the European Community. E.C. limitations apply. A presence in the country would facilitate access.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The areas that offer good opportunities for Canadians are: automotive electronics, aerospace, tool making, machine tools, pollution and environmental control, factory automation, plastics, industrial engineering and biotechnology.

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3.15 GREECE

The Greek GDP is about 8,300 billion Drachmas (C$58 billion). Greece has a small industrial base with manufacturing representing only 20 percent of the GDP. The agricultural sector represents 17 percent of the GDP while the heart of the economy remains the service sector which represents over 56 percent of the GDP. ● ●

The expenditure on R&D in 1989 was 0.20 percent of GDP.

TECHNOLOGY TRENDS/STRENGTHS

Greece is an agriculture oriented country, but government policy is directed towards industrialization and technological development. There is no single thrust for the development of any specific sector, but rather a general effort for overall industrial growth.

The main R&D expenditures are made by the government (74.4 percent). Public enterprises spends 13.8 percent and private enterprises 9.4 percent. There is no specific sector favoured or exhibiting a particular strength, but interesting niche technologies exist amongst companies such as Petzetakis in plastics and in yogurt technology.

KEY ORGANIZATIONS

These include:

- the Ministry of Industry, Energy and Technology (which also operates the National Pailnis Office)
- the Ministry of National Economy
- the Ministry of Agriculture
- the Hellenic Industrial Development Bank
- also universities of Athens, Tessaloniki, Pathras and Crete Institute

KEY SUPPORT PROGRAMS

The Greek government cooperates closely with all the E.C. sponsored R&D programs and also supports the following programs:

- the Program for Supporting Human Research Resources (Channelco through universities)
- the Program for Development of Industrial Research
- All the E.C. coordinated programs
  - an example of which is a future project concerning refuse pro cessing.

CONDITIONS OF ACCESS

Foreign firms and research organizations can freely participate in the above programs subject to approval by the Ministry of Industry, Energy and Technology.

Licensing of technology is the responsibility of the same ministry. Fees for the license are approved by the Ministry of National Economy.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

These exist through niche industrial opportunities and through off-shoots from the E.C. research programs, (AIM, GAP, SCA, GRIDGE, and CTSC) for which only European entities are eligible.

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3.16 PORTUGAL

Portugal has a GDP of 6.90 trillion Escudos (C$53.27 billion) and a population of 10.4 million. ● ●

The key industrial sectors are: textile, clothing and footwear, timber, cork and paper pulp and machinery.

The expenditures on R&D are 47.36 billion Escudos (C$365 million) or 0.68 percent of GDP.

The state finances 63.5 percent of the total, while the companies pay 26.8 percent and the universities and private not-for-profit organizations make up the remainder.

TECHNOLOGY TRENDS/STRENGTHS

R&D expenditures by the state concentrated on natural and exact sciences (29.7 percent), engineering (30.0 percent) and agriculture, forestry, livestock, hunting and fisheries (18.9 percent). Enterprises, in turn, concentrated heavily on manufacturing (68.2 percent) with services (transport, communications, banking, etc.) a fair second (20.9 percent).

KEY ORGANIZATIONS/ PROGRAMS

The state's direct contribution involves practically all of the state institutes which in 1990 will receive from the government budget a total of 18,108 million Escudos (approximately C$140 million), to cover their R&D expenditures. The largest single share (5,230 million Escudos) will go to the *National Board for Scientific and Technological Research (JNICT)* which, among other things, is responsible for supporting "the implementation of programs and projects relating to scientific research, experimental development, and innovation". A rather distant second is the *National Laboratory of Engineering and Industrial Technology (LNETI)* with 3,608 million Escudos followed by the National Institute of Agricultural Research (INIA) with 2,555 million Escudos.

As in other sectors, E.C. funding plays a significant role. In fact, 2,000 of JNICT's 5,230 million Escudos (above) are earmarked as Portugal's "counterpart" in the new "CIENCIA" program. CIENCIA received government approval in June 1989 and will be expected, in 1990-1993, to "mobilize funding" at levels not previously experienced. It will support "quality" R&D in areas of great interest to the country, and will marshall the energies of the "Portuguese scientific community in the country and abroad".

CONDITIONS OF ACCESS

Portugal is open to cooperation with foreign firms and research organizations provided that they meet the requirements established by the E.C. which is that the Canadian entity have a local "presence".

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunities exist in the fisheries and the clothing industry.

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4.0 MIDDLE EAST

4.1 ISRAEL

The 1988 GDP was 69 billion N. Shekels (C$40 billion). The population is 4.5 million. The top industrial exports are: diamonds, high tech products (electronics, electro-optics, telecommunications, avionics, medical electronics), and agricultural products.

R&D expenditures are 3.1 percent of GDP. The sources of R&D expenditures are: 51.0 percent at the Ministry of Defence; 22.3 percent at the universities and research institutes, 14.8 percent at government agencies; and 11.5 percent in industry.

TECHNOLOGY TRENDS

In Israel, a distinction is drawn between scientific and technological activities. In the area of science, Israel hopes to maintain a minimal international level of excellence across a broad spectrum of scientific fields by encouraging the establishment of centres of excellence, especially in areas of vital concern to the development of industry. International cooperation has played a major role in above effort by facilitating the extension of scientific resources and knowledge at Israel's disposal. In the area of technology, Israel has striven for excellence primarily through specialization.

Strong support is given to industrial R&D in sectors with large R&D expenditures as a percent of sales because these firms export a higher proportion of their sales than firms expending a smaller fraction of their sales on R&D. Fostering the continued growth of these types of firms is presently at the heart of Israel's industrial strategy.

TECHNOLOGY STRENGTHS

These are:

- defence industries (telecommunications, avionics/optronics)
- medicine (neurobiology, cancer, cardiovascular disease)
- computer science
- agriculture (irrigation, aquaculture, automation in agriculture)

KEY ORGANIZATIONS

These are:

- Ministerial Committee for Science and Technology appointed by Cabinet. It determines national long term policy for the advancement of scientific research and development
- Ministry of Science and Development which oversees and guides national R&D efforts
- National Council for R&D (NCRD) which is in charge of fostering international relations
- Israel Space Agency
- National Steering Committee on biotechnology
- Chief Scientists' Forum - made up of the chief scientists of the various ministries
- Israel Patent Office which is attached to Ministry of Justice non-governmental R&D policy-making organizations
- Israel Academy of Sciences and Humanities
- Council for Higher Education

KEY SUPPORT PROGRAMS

Through the National Council for Research and Development, Israel has established scientific cooperation at governmental levels with more than 20 countries and regional international organizations.

Key Support Programs are:

- Exchange of scientists and convening of scientists' conferences
- Extensive programs of cooperative research. Such programs are underway between Israel and the Federal Republic of Germany, the United States, France and the European Community
- Israel's international development cooperation program, Masmav is a division of the Ministry of Foreign Affairs. Its activities include training, research projects, institutional support and other forms of technology transfer to developing countries
- Bi-national research funds for joint R&D (eg. United States, Israel Bi-national Science Foundation, Bard-United States, Israel Binational, agricultural research and development, BIRD-Israel - United States Bi-national Industrial R&D Foundation, GIF-German - Israel Foundation for Scientific R&D)

CONDITIONS OF ACCESS

The National Research Council of Canada and the Office of the Chief Scientist of the Ministry of Trade of Israel signed a Memorandum of Understanding (MOU) for joint R&D in 1986. The MOU is between NRC and the office of the chief scientist of the Ministry of Trade in Israel. Foreign firms and organizations wishing to collaborate will find very willing partners in Israel, both in industry and in academic institutions. There are abundant technologies available seeking international partners for further development and marketing.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Within the framework of the MOU for joint R&D, a fertile ground has been established for co-operation between Canadian and Israeli firms. The following sectors offer opportunities for technology transfer: telecommunications, optronics, electro-optical, tactical electronic equipment, composite materials, biotechnology, genetic engineering, medical electronics, and agricultural technologies.

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5.0 ASIA/PACIFIC RIM

5.1 JAPAN

Japan is the world's second largest industrial economy after the United States. Its 1988 GDP was some 40,000 billion Yen (C$3,000 billion) and its per capita GDP (population 123 million) exceeded that of the United States. In 1989, Japan's per capita income rose to become the highest in the world. The world's ten largest banks are now Japanese.

Japan spends about 2.8 percent of its GDP on R&D. Some 80 percent of national R&D expenditures are financed by the private sector, the highest ratio of the industrialized nations.

TECHNOLOGY TRENDS

A 1986 Cabinet decision established the General Guidelines for Science and Technology Policy in Japan. These guidelines include the following areas of concentration;

- basic sciences and fundamental technologies which impact progress in other fields (advanced materials, information technologies, life sciences, software, space, ocean and earth sciences)
- science and technology which stimulates economic growth (natural resources, energy, recycling, production and distribution systems, service to society)
- science and technology which improves the quality of life (mental/physical health, culture, human, environment, safety and comfort).

The three major S&T funding agencies of government are the Ministry of Education, Science & Culture, the Science & Technology Agency (STA) and the Ministry of International Trade and Industry (MITI), which in general fund basic, respectively applied and product development research.

National technology thrusts are normally promulgated via National or Large-Scale projects in which the government funds a substantial amount (See Key Organizations). The basic thrust of Japan's current strategy in S&T is to move upstream into basic research which will provide the foundation of Japan's future technologies. Basic research accounted for 14 percent of Japan's R&D expenditures in 1987, while applied research accounted for 24.3 percent, and experimental development 61.7 percent.

Internationalization is another pillar of Japan's S&T strategy. In the past few years a number of major programs have been initiated by Japan (see Key Support Programs).

TECHNOLOGY STRENGTHS

From aquaculture to robots Japan is among the best in the world. Japan is a world leader in advanced manufacturing technologies, micro-electronics, automobiles and automotive components and assemblies, energy technologies, and food processing. It is also extremely strong in construction technology, aquaculture and optoelectronics, among others.

KEY ORGANIZATIONS

The lead organizations in Japan are:

- *Ministry of International Trade and Industry (MITI)*
  MITI is responsible for industrial and trade policy development in Japan. It plays a key role in industrial technology development (see AIST below), and has overall responsibility for ensuring that Japan's industrial economy grows in a coherent fashion.
- *Agency of Industrial Science & Technology (AIST)*
  AIST has sixteen national laboratories which are industry-oriented, a staff of some 4,000. There are seven regional labs which are charged with technology development based on the strengths of the individual regions.

  Centrally, AIST administers the *Basic Technologies for Future Industries* project, and a number of so-called National and Large-Scale projects. It is also responsible for the *Sunshine* (new energy sources) and *Moonlight* (energy conservation) technology programs. The provision of technological information and technology diffusion are also in AIST's mandate.
- *Science & Technology Agency (STA)*
  The STA, an arm of the Prime Minister's Office, has central responsibility and authority for all science and technology development in Japan. It has some 2,200 employees. Its key missions can be summarized as follows:
  - planning and implementation of national S&T policies
  - coordination of government's S&T expenditures excluding education
  - promoting technology development in strategic fields including atomic energy, space, oceans, etc.
  - bolstering basic research in Japan
  - co-ordinating all international S&T activities, both multilateral and bilateral.
- *Research Development Corporation of Japan (JRDC)*
  JRDC links researchers and inventors with companies. It has a number of programs which promote the transfer of research completed in the institutional sector to the private sector. JRDC also funds private sector research and development and coordinates technology transfer both within and outside of Japan.
- *Japan Key Technology Centre (KEYTEC)*
  KEYTEC was established in 1985 jointly by the Japanese government and the private sector with the objective of promoting private sector technology development in strategic fields. It provides venture capital funds and loans for eligible projects, and puts together research consortia on a contract basis.
- *Japan Industrial Technology Association (JITA)*
  JITA is a non-profit organization funded by and closely affiliated with MITI/AIST. It has long been the funnel by which AIST technology is transferred to the private sector in Japan, and of late has been concentrating on international transfer of Japanese intellectual property. JITA runs an intellectual property mission to North America every year with a view to showcasing available technologies.
- *New Energy and Industrial Development Organization (NEDO)*
  Also an AIST affiliate, NEDO manages the Sunshine and Moonlight Projects, among others (see Key Support Programs). It also takes on a significant role in non-energy technology development in Japan. NEDO will be a source of funds for private firms' R&D efforts and will also administer a number of the large scale projects. There is now a multi-million

dollar International Joint Research grant program which reviews and selects appropriate projects internationally from the life sciences and advanced materials fields

KEY SUPPORT PROGRAMS

The main support programs include the following:

Internationalization

- *JRDC International Research Program*
  JRDC will select large scale bilateral R&D projects from proposals submitted to it by foreign countries. Cost sharing on a 50/50 basis is expected.
- *Human Frontier Science Program (HFSP)*
  The 1990 funding will be approximately C$30 million. Canadian researchers, corporate or institutional, can avail themselves of HFSP funding following an application and peer review process (Medical Research Council of Canada is the Canadian contact).
- *STA and Ministry of Education Fellowship Programs*
  The two programs are funding hundreds of foreign researchers to work with their Japanese counterparts in Japanese labs. Over 250 positions are available in 1990, and Canada is eligible for over 20. The Natural Sciences and Engineering Research Council (NSERC) coordinates the program in Canada.
- *MITI/AIST International Research Programs*
  A number of programs are available to foreign entities in a number of sectors, many of which require a membership fee to participate.

National Programs

- *Exploratory Research for Advanced Technology Program (ERATO)*
  JRDC funds and manages ERATO which funds leading edge R&D in everything from solid state physics to biophotons. Projects are carried out in the existing labs of the partners. Last year's budget was C$40 million.
- *Frontier Research Program*
  Similar to ERATO, this program is managed by the STA's Institute for Physical and Chemical Research (RIKEN). It is directed towards life and material sciences.
- *Large Scale Projects*
  These AIST-funded and NEDO-managed projects are strategic technology development initiatives. Corporations, government labs and, to some extent, universities work together towards a national objective. Current projects of interest include:
  - Advanced robotics (1989 budget of C$20 million)
  - Water treatment (1989 budget of C$20 million)
  - Interoperable Databases (1989 budget of C$11 million)
  - Advanced material processing/machining (1989 budget C$19 million)

  Effective this year, foreign enterprises are eligible to participate in all "Large-Scale" projects.
- *Sunshine and Moonlight Projects*
  These NEDO projects are targeted at developing alternative energy sources (solar, geothermal, coal, wind, and hydrogen) and energy-conserving technologies (superheat pumps, and fuel cells)
- *Fifth Generation Computing*
  This is a national project which commenced in 1982. Managed by the Institute for New Generation Computer Technology (ICOT), a combination of government and private sector human and financial resources, its target is literally the fifth generation computer using AI and parallel processing.

CONDITIONS OF ACCESS

Government programs, which have often excluded foreign participants in the past, are slowly opening to international participation. In the past two years alone, at least four major initiatives of Japan totalling over C$100 million have not only been opened to foreign organizations, but created with their participation in mind.

Intellectual property in Japan is controlled by the Japanese Patent Agency. While the patent process is similar to that of both Canada and the European Community nations, the Japanese system is first to file. Patent applications in Japan sometimes take an inordinate amount of time to fruition (up to three years), and a good patent attorney is a necessity.

Both the government and private sector are willing licensors. Individual agreements can be tailored to the tastes of the parties involved. Government licenses are often extremely cheap.

The biggest barrier to access is not technical, but cultural. The use of Japanese professionals for cultural and language interpretation is a must.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

These abound in virtually every sector of the Japanese economy. Successes include everything from scallop aquaculture to advanced debit card technologies. In the strategic sectors there are abundant opportunities in advanced materials, automotive industries, advanced manufacturing and chemical/plastic products. Environmental, food, and resource technologies also hold promise.

Canada has a bilateral science and technology agreement with Japan which was signed in 1986. More recently, the federal government has approved a Japan Science and Technology Fund which will enhance science and technological collaboration with that country.

The Japanese also remain one of the world's most prolific licensees of foreign technologies. Opportunities are also numerous here.

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5.2 SOUTH KOREA

South Korea, with a population of approximately 42 million, had a growth of GDP of 11.3 percent in 1988. Korea increased its expenditures on R&D from 0.9 percent of GDP, in 1981 to 2.6 percent of GDP in 1989. The plan is to reach 3.0 percent of GDP in the year 2001. The GDP for 1989 was estimated to be 145,000 billion Won (C$250 billion). The real economic growth in 1989 was 7.5 percent.

Key economic sectors include automobile production, steel production, industrial chemicals, and electronic products.

TECHNOLOGY TRENDS/STRENGTHS

The primary science and technology policy directions emphasize creation rather than imitation, in developing selected high-tech areas toward the 21st century, and strengthening science programs for the younger generation. The Korean government plans to increase the numbers of scientists and engineers from 13 per 10,000 (1987) to 30 per 10,000 by 2001.

Through the use of financial incentives, the Korean government has encouraged the growth of private research institutes from 52 in 1980 to 503 in 1988, and research consortia from 0 to 37 in the same period.

In their *Long-range Plan of Science and Technology Toward the 2000's*, Korea has identified the following technologies as important:

- information technologies and automation
- fine chemicals
- precision machinery
- biotechnology
- new materials
- environmental technologies
- health technologies
- oceanography
- aeronautics

There is also greater emphasis being placed on basic research.

KEY ORGANIZATIONS/ SUPPORT PROGRAMS

These include:

- *Korea Advanced Institute of Science and Technology (KAIST)*
  A major government sponsored research institute located on the outskirts of Seoul, it engages in cooperative research projects with private sector and academic laboratories.
- *Korea Science and Engineering Foundation (KOSEF)*
  KOSEF plays a major role in the training of scientific personnel, including supporting Korean scientists in conducting joint research with their foreign counterparts. KOSEF conducts joint research, holds research seminars, exchanges scientists and science and technology information with foreign organizations.

CONDITIONS OF ACCESS

Government relaxation of technology transfer restrictions facilitate access to Korean technology. The Small and Medium Industry Promotion Organization facilitates the contacts and the negotiation process between licensee and licensor.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Major opportunities exist in the expanding electronic/software, aerospace equipment, communications, automotive parts and agricultural food sectors.

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5.3 PEOPLE'S REPUBLIC OF CHINA

China, with a population of 1.1 billion, had a GDP of RMB 1.385 trillion in 1988 (C$330 billion) an 11.2 percent increase over 1987. Key industrial sectors include, agriculture, energy, petroleum and petrochemicals, metals and minerals, transportation, machinery, and telecommunication. ● ●

TECHNOLOGY TRENDS

Because of China's numerous needs, technology development thrusts are in the following fields: agriculture (chemical fertilizer plant, farm machinery, pesticides); energy (hydro, coal fired and nuclear power); petroleum and petrochemical (ethylene, polyethylene, propylene, carbon disulphide, etc); metals and minerals (steel, aluminum, lead and zinc); transportation (railways, waterways, port, aviation, car); and telecommunications (switchboard, packet switching, fibre optic, microwave).

The government recently outlined its funding priorities and listed 30 key projects involving power supplies, ports, airports, plants producing chemical fertilizers, aluminum, copper, cement, heavy duty trucks, ethylene, colour television tubes, detergents and electric generating equipment. Briefly, China will expand infrastructure project investments in energy, raw materials and communications (both telecommunications and transportation).

KEY ORGANIZATIONS

There are more than 200 science and technology research institutes and centres in China. The most important ones are:

- Chinese Academy of Science
- State Science and Technology Commission
- Beijing New Technology Application Research Institute
- Beijing Machinery and Electricity Institute
- Beijing Agricultural Machinery Research Institute
- Beijing Automotive Industry Research and Development Centre
- Central Iron & Steel Research Institute
- Beijing Information-Optics Instruments Institute
- Organization responsible for patents and licensing of technology: China Patent Office

KEY SUPPORT PROGRAMS

The turn key support programs are the China Association of Science and Trade (CAST) and the China Council for the Promotion of International Trade (CCPITT).

CONDITIONS OF ACCESS

Viable business opportunities exist in many areas, but cool and realistic assessment is essential. Decision to enter the market requires long-term commitment of the resources needed to achieve success and acceptance of the probability that, initially, results may be minor and long-delayed. China's potential and current circumstances justify a special approach. There is a need to accept less well defined and precise operating circumstances than usual. Initial profits should be used to expand the local base of operations. It is essential to check to what extent any proprietary technology will be protected under the patent and copyright system (April 1985, currently under review) before entering into a joint venture.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Canadian firms and research organizations have little to gain from Chinese technology. But innovative niche technologies can often be found in universities or research institutes. Often they were developed for internal use to overcome an inability to purchase goods abroad. Sometimes these rough products or prototypes can be further developed, and commercialized. The Chinese will negotiate some type of shared marketing scheme, but have little ability to sell outside China.

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5.4 INDIA

India has a GDP of RS 2,933 billion (C$200 billion) and a population of 797 million. The focus of its industrial production is food, textiles, metallurgy, mechanical engineering, electrical engineering and chemicals.

India spends about 1.13 percent of its GDP on R&D.

TECHNOLOGY TRENDS

The Indian government has targeted the following areas:

- environment
- ocean technologies
- non-conventional energy sources
- biotechnology
- space technologies (eg. telecommunications)
- electronics (eg. electronic switching, LSI/VLSI, computer architecture)
- nuclear power

TECHNOLOGY STRENGTHS

India's technology strengths include the space program, defence R&D and computer software.

KEY ORGANIZATIONS

A principal agency is the Council of Scientific and Industrial Research (CSIR). This organization consists of a network of 39 national laboratories, two cooperative research associations and 100 extension field centres. The Council's research programs are directed towards the effective utilization of India's natural resources and development of new processes and products for economic progress.

Other organizations include:

- The National Remote Sensing Agency (NRSA)
- India Space Research Organization (ISRO)
- Centre for Development of Telematics (C-DOT)
- Geographical Survey of India
- Centre for Development of Advanced Computing (C-DAC)

KEY SUPPORT PROGRAMS

Support is directed to sectors such as space, military and telecommunications more than to support of manufacturing per se.

CONDITIONS OF ACCESS

While imports are discouraged, technology transfer agreements stimulating manufacturing in India are permitted. While India offers only niche technologies for outward licensing, exchanges of expertise and know how are unrestricted. Government approval procedures are to be accelerated for industrial collaboration.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Principal opportunities are in communication technology, defence and software.

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5.5 AUSTRALIA

Australia's gross domestic product (GDP) in 1987-88 stood at A$292 billion (C$260 billion). Real GDP growth in 1987-88 was 3.6 percent. The country spends about 1.2 percent of its GDP on R&D with industry contributing about 37 percent.

Australia has one of the largest livestock industries and is the world's leading supplier of wool, accounting for about 50 percent of international wool exports. Metal and mineral exports account for more than 28 percent of export earnings. Manufacturing accounts for about 17 percent of GDP.

International trade accounts for about 28 percent of Australia's gross domestic product. On a composition of trade basis, agricultural product exports constitute 25 percent of total export values and minerals another 24 percent.

TECHNOLOGY TRENDS

The announced priority of the government is to internationalize Australian industry and research. The thrust of its R&D policy is to improve the competitiveness of Australian firms by increasing their productivity. It is promoting strategic alliances, research collaboration, methods to restructure its mature industries (mining, agriculture and heavy manufacturing), and developing new industries in information technologies, aerospace, biotechnology and environment.

TECHNOLOGY STRENGTHS

Australia is prime supplier of Zirconia powders, rare earths, gallium and silicon metal. There are also developments in ceramics (based on Zirconia). There are 30 university departments and 30 in government doing R&D in new materials. In agriculture, biotechnology is playing a strong role in developing new strains of plant products and in animal virus control. Food processing is also a strong sector for innovation.

In minerals and metals processing, new techniques for smelting are being developed.

In the newer industries, innovation is strongest in the information technology field, particularly in software and communications. Telecom Australia, the Overseas Telecommunications Corporation and several private sector firms and universities are developing capabilities in optoelectronics and integrated services digital networks (ISDN).

KEY ORGANIZATIONS

These include:

- CSIRO: similar to Canada's NRC, primarily concerned with developing new technologies primarily in Agriculture and Food, Minerals and Energy, and Manufacturing industries.
- DSTO: Primary interest in technology for the defence industry
- DITAC: Industry development - industry patent Office and support program for R&D program and international co-operation
- TELECOM: Large R&D program for Telecommunications research: ISDN, Optical Fibre.
- OTC: Large R&D program in transmission, networks and applications. Strengths in optoelectronics and satellite communication. Latter shared with AUSSAT, the Australian Satellite Organization (public company).

KEY SUPPORT PROGRAMS

These include:

- Grants for Industry R&D (GIRD)
  - support to small firms
  - support for joint R&D
- Tax concessions for industrial R&D (150 percent)
- Management and Investment Companies (MIC)
  - subsidized venture capital companies to provide management and financial support
- Australian Industry Development Council
  - the Governments own venture capital firm
- Partnership for Development Program
  - program to attract foreign high tech firms by removing offset requirements for R&D and trade promises
- International Licensing Network Link

CONDITIONS OF ACCESS

There are no specific conditions. The technology transfer agreements and the process are very similar to that in place in Canada, and operate on a commercial basis.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Australia's strengths lie in technologies for agriculture, food processing, mining and metallurgy, and represent real opportunities. The information technology sector is also very strong in certain niche areas [eg. banking software, data communications, optoelectronics, space communications and integrated services digital networks (ISDN)].

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5.6 NEW ZEALAND

New Zealand has a total population of 3.4 million located on three islands that contain 267,000 square kilometres. New Zealand invests approximately 1.4 percent (1987) of its GDP in R&D. Its GDP in 1988 was NZ$59.2 billion (C$40 billion).

TECHNOLOGY TRENDS

The bulk of R&D is conducted in government supported laboratories and research institutions. Therefore, the research objectives of the Department of Scientific and Industrial Research (DSIR) can be considered to reflect the objectives of government R&D policy.

KEY TECHNOLOGICAL STRENGTHS

These include:

- agricultural biotechnology
- compressed natural gas technology

KEY R&D SUPPORT PROGRAMS

A main program is:
The Development Finance Corporation Applied Technology Program

This program spent approximately NZ$3.9 million in 1985/86 to assist New Zealand industry undertake R&D.

KEY ORGANIZATIONS

The principal technology development organizations are: Department of Scientific and Industrial Research (DSIR). DSIR is New Zealand's main government research organization and also New Zealand's major plant breeding organization conducting studies in molecular genetics, biochemistry and plant process engineering. DSIR also conducts research into:

- industrial chemistry and biotechnology (eg. bioprocessing, microbial cultures, insect bioassays, and fermentation)
- physics and mathematics (eg. metals corrosion, new ceramics, radioactive tracers, and materials characterization)
- mechanical engineering (eg. alternative fuels technology (methanol), biomechanics, advanced production technologies)
- electronics and information technology (eg. machine vision, digital communications, satellite image processing, expert systems, chip development)
- ecological science (eg. animal and plant identification, pest management, plant diseases)
- land and such resources (eg. soil and rock mechanics, waste and efficient disposal and geotechnical investigations)
- water science and resources (eg. groundwater studies, river hychology and fish habitat assessment)
- earth sciences (eg. ultra-trace metal analysis, geological well logging, seismic monitoring)
- atmospheric studies (eg. greenhouse effect and ozone levels)

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The main opportunity areas are in agriculture and animal products.

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5.7 SINGAPORE

The Republic of Singapore is a small, highly urbanized and affluent democratic city state. The country's socio-economic activity as defined by total trade in 1988 is S$170 billion (C$105.4 billion). The population is 2.6 million.

Some 45 percent of the work force is employed in the manufacturing sector in the following four major industries:

- electronic and electrical industry;
- ship and oil rig building and repairs;
- petroleum products and bi-products; and
- consumer goods.

Singapore has the most developed and well-equipped education and research facilities in the whole of South East Asia. Singapore has 3,361 researchers.

TECHNOLOGY TRENDS

Technology Development is centred around four principal sectors (all within the country):

- electronics
- computer hardware and software
- robotics, automization and engineering equipment
- biotechnology

TECHNOLOGY STRENGTHS

A number of large firms in the country, which are mostly MNCS are: AT&T, Hewlett Packard, Digital, Philips, Sony, Matsushita, Dupont, Far East Livingston, BP, Exxon, Seagate, Glaxo, SGS-Thompson, etc. These companies have been the focii for the development of technological strengths in areas such as electronics, computer hardware and software, petroleum bi-products, chemicals, engineering equipment, and pharmaceuticals.

KEY ORGANIZATIONS

Singapore has a concentration of both public and private technology development organizations. Publicly funded institutions include Singapore Institute of Standards and Industrial Research (SISIR), Institute of Molecular and Cell Biology (IMCB), Institute of System Sciences (ISS) at the National University of Singapore, Japan Singapore Institute of Software Technology, and the Science Council of Singapore. All these institutions are situated at the Singapore Science Park, and they employ about 2,000 research scientists and engineers.

Private technology development organizations in Singapore, are for example: CCS or Centre for Computer Studies a partnership between ICL (UK) and NGEE ANN Polytechnic and Northern Telecom (Canada) joint research projects with Nanyang Technological Institute.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

The key areas of opportunity are electronics, computer hardware and software, robotics, automation and engineering equipment, biotechnology, petroleum bi-products, chemicals, pharmaceuticals and telecommunications equipment.

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6.0 EASTERN EUROPE

6.1 SOVIET UNION

The Soviet Union is the largest country in the world (22.5 million square kilometres) and has a population of more than 280 million.

It has a large primary resources development sector which accounts for 85 percent of Soviet exports. Manufactured exports are largely in the machinery and equipment sector.

The push to restructure the economy and to accelerate production is based on the introduction of new technology.

TECHNOLOGY TRENDS

The new economic system set in place in 1988 links science and technology to the economy by placing research institutes on a contract basis with the clients of their services.

The following are major science and technology programs being undertaken by the USSR:

- high energy physics (eg. investigation of weak and strong electron interactions, and solar and stellar particle streams and energy generating mechanisms)
- high temperature superconductors (eg. development of industrial processes to manufacture HTS, and development of HTS devices)
- exploration of the planet Mars (eg. development of a detailed engineering model of Mars, and study of the technical feasibility of a manned expedition)
- human genome program (eg. complete decoding of the molecular structure of the human genome involving chromosome mapping and sequencing of DNA)
- emerging information technologies (eg. development of super computers, ultra-high capacity external storage devices, artificial intelligence systems, and computerized information networks)
- advanced manufacturing technologies, machines and production systems (eg. new farming methods using high-density energy, ultra-high pressures, etc; CAM; intelligent (self-learning) robots using opto and bio-sensory systems, and high precision machine tools)
- advanced materials (eg. radiation and hydrogen resistant steels, alloys with amorphous and micro-crystalline structure; shape memory alloys and steels; new structural ceramics with high impact viscosity, ceramic membranes with adjustable channel size; metal and polymer matrix composites, structural polymers, special purpose polymeric materials, stalls with high bio-compatibility and super strong glass fibres)
- bio-engineering (eg. production of recombinant micro-organisms, transgenic plants and animals, bio-leeching processes for mining and pollution control, construction of peptides and proteins for diagnostic and therapeutic uses, development of extra-cellular proteins, and production of bio-catalysts).
- high-speed non-polluting transport (eg. development of naval transport technologies such as high speed trains, mag-lev vehicles and non-polluting automobiles)

- clean energy (eg. from safer nuclear power stations, non-polluting thermal power stations using low grade fuel, solar/wind/geothermal sources, and more efficient forms of fuels based on more extensive processing of coal and natural gas)
- resource-efficient and non-polluting metallurgical and chemical processes (eg. development of new technologies concerned with rolled metal manufacture, turbulent flow reactors in chemical processes, non-polluting cellulose manufacture, and membrane processes for concentrating products and clarifying waste water in small scale chemical plants)
- high-efficiency food manufacturing processes (eg. development of safe means of soil enhancement, of integrated systems of plant protection using environmentally safe biological and chemical agents, production of high yield plants and animals, manufacture of food and fodder protein, development of biological and physio-chemical storage and transportation mechanisms for farm produce, and development of mariculture technologies for cultivating saltwater fish, etc., and for the combined processing of the animals and plants cultivated with the aim of producing high quality food products, biologically active substances and feed items)
- prevention, diagnosis and treatment of widespread diseases (eg. atherosclerosis, oncological diseases, viral infections, alcohol/drug/toxic substance abuse and AIDS)
- advances in building technology and materials (eg. development of new structural materials and members)

TECHNOLOGY STRENGTHS

The Soviet Union is well recognized in space research, space technology, laser technology and thermonuclear fusion.

KEY ORGANIZATIONS/ SUPPORT PROGRAMS

The principal technology-related organizations are:

- *Gosplan USSR*

  Gosplan is responsible for all aspects of economic planning in the USSR. Its main role in relation to R&D is in the planning of the introduction of innovations into the economy, but it also plays a part in the allocation of resources and suppliers for use in science.

  Organizationally, it is divided into two main types of departments which include those concerned with particular industries. The department most closely concerned with innovation is the Department of Aggregate Planning for the Introduction of the Achievements of Science and Technology into the National Economy. It works closely with the State Committee for Science and Technology and the Academy of Sciences.

- *State Committee for Science and Technology*

  The Committee has five main functions:
  - planning the development of science
  - supervision over the fulfilment of the plan
  - the establishment of rules and standards for the conduct of research and development
  - the processing and dissemination of scientific and technical information
  - the arrangement of foreign contacts.

The State Committee only has two to three percent of the science budget to allocate to promising lines of research.

- *USSR Academy of Sciences*
  The Academy is the country's highest scientific establishment. It is responsible for promoting basic research in both the natural and social sciences and for implementing research in promising spheres of industrial development. The Academy has 332 full and 597 corresponding members. The Academy is comprised of 17 scientific divisions and three regional divisions. The research within this framework is carried out by more than 300 institutions.

CONDITIONS OF ACCESS

The sale and purchase of patents, licenses and "know how" falls within the purview of the Licensintorg of the Ministry of Foreign Trade. This agency acts as a broker in arranging technology transfer agreements.

Economic restructuring is now stressing joint ventures between foreign and Soviet companies.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

Opportunities exist principally in the areas of space technology, nuclear, and resource development. However, there are also major opportunities to sell technology to assist the current economic restructuring.

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6.2 HUNGARY

Hungary, with a population of 10.6 million in an area of 93,000 square kilometres had a GDP of 993.9 billion Forints (C$18 billion) in 1987. ● ●

The important industries are agriculture and food processing, engineering, chemicals and light industries.

TECHNOLOGY TRENDS/STRENGTHS

Medium-term plans for 1986-1990 call for expenditures of 152-164 billion Forints on R&D.

Under their 1986-1987 National Medium term R&D Plan, the Hungarians have identified the following as priority areas:

- basic research in biology
- microelectronics (eg. data processing, telecommunications and automation)
- reasonable utilization of raw and waste material and associated technologies
- biotechnology
- energy management
- electronic components
- automation of technology
- electronic instrumentation in precision mechanics
- pharmaceuticals (eg. plant protection, haematherapeutic and diagnostic compound production)
- food production

KEY ORGANIZATIONS

The State Committee for Technological Development

This committee is responsible for national R&D planning, co-ordination in allocating development resources and in maintaining international science and technology relations.

Hungarian Academy of Sciences

The Hungarian Academy of Sciences is the supreme scientific body and has two main roles:

- participates in the national direction and control of scientific research, and acts as a corporate scientific body; and
- supervises its institutions carrying out research funded mainly from the state budget

Of the 68 institutes dealing with R&D activities, 36 are under the supervision of the academy.

KEY SUPPORT PROGRAMS

The Technological Development Fund

Funded by compulsory tax on the price of industrial goods, this centralized national fund is used by ministries and agencies directly subordinated to the Council of Ministers for supporting R&D projects directly or indirectly aimed at upgrading economic activity. This fund, in 1985, constituted 22 percent of the total R&D expenditure of the country.

National Scientific Research Foundation

Established in 1985, the foundation has about 4 billion Forints available over five years to award grants for both basic research and for improvements to the research infrastructure.

CONDITIONS OF ACCESS

Hungary is a planned economy which encourages joint ventures with foreign entities. To facilitate international cooperation, the law on the Investments of Foreigners in Hungary was passed in 1988. For example, this law protects foreigners against nationalization or expropriation.

TECHNOLOGICAL OPPORTUNITIES FOR CANADIANS

While there could be niche opportunities to access technology, there are possibly more opportunities to sell technology useful to the development of a sophisticated industrial structure.

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