

2nd Annual Forum on Advanced Manufacturing and Aerospace Robotics

**Summary Report
July 1999**

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1. Executive Summary

The Italian Trade Commission, in collaboration with the Universities of Toronto and Padova, initiated a number of activities this year to encourage the exchange of knowledge and business information in the areas of advanced manufacturing and robotics with emphasis on aerospace applications between Canada and Italy.

Three major initiatives were carried out:

- 1) A faculty member of the University of Toronto's Dept of Mechanical Engineering, Dr. Duncan Newman, visited the University of Padova to exchange information. During this meeting, Dr. Francesco Angrilli and Dr. Newman discussed ideas to be further explored in a joint videoconference between the two organizations.
- 2) A videoconference between Italy and Canada was held on June 9, 1999. This event provided the opportunity for researchers and industry representatives to exchange information specifically in the area of aerospace robotics.
- 3) An overview report (attached) of Canadian activities in the area of advanced manufacturing and aerospace was developed by the Professional Development Centre at the University of Toronto with input from faculty from the University of Padova.

As a result of these activities, a number of valuable links have been made between academics in Canada and Italy involved in similar research areas. The exchange of information has already proved beneficial to both universities, and future collaboration is under discussion.

The attached report is a compilation of resources and initiatives in Canada related to the areas of advanced manufacturing and the aerospace industry. The report covers Canada's business and trade strategy in these areas, government supports agencies, trade associations, universities and companies.

It has been a pleasure to work with the Italian Trade Commission on this important initiative. We intend to build on the foundations that have been laid through their work and continue this important dialogue with our colleagues in Italy.

Leslie Dolman
Director

Professional Development Centre,
Faculty of Applied Science and Engineering

1. Notes on Sourcing

The 2nd Annual Forum on Advanced Manufacturing and Aerospace Robotics is an initiative of the Italian Trade Commission, an initiative with which the Professional Development Centre is proud to be involved.

Upon the request of the Italian Trade Commission, the PDC compiled a document including

1. A body report on Advanced Manufacturing Technologies and Aerospace Robotics
2. Appendices on:

Federal Organizations (Canadian International Business Strategy, Industry Canada, Strategis, the National Research Council) Program

Other Federally or Provincially Supported Organizations (Canadian Technology Network, Natural Sciences and Engineering Research Council of Canada, Alberta Research Council, Centre Prototech, Centre de recherche industrielle du Quebec, Inforex, InNOVAcorp, Materials and Manufacturing Ontario, PRECARN Associates Inc., Canadian Space Agency, Centre for Research in Earth and Space Technology, Center for Technologies in Aerospace, Communications Research Centre Canada, Ontario Aerospace Council

Trade Associations (Alliance of Manufacturers and Exporters Canada, Automotive Parts Manufacturers' Association, Canadian Advanced Technology Association, Canadian Association of Mining Equipment and Services for Export, Canadian Association of Moldmakers, Canadian Plastics Industry Association, Canadian Tooling & Machining Association, Electro-Federation Canada, Industrial Research + Development Institute, Machinery & Equipment Manufacturers' Association of Canada, Aerospace Industries Association of Canada, Canadian Aeronautics and Space Institute)

Universities

Industry

The body documents are primarily sourced from the Strategis Canada website; this source is cited in the research document provided to the Italian Trade Commission. For other sources, websites are provided wherever possible. Furthermore, the Professional Development Centre thanks Mr. Rod Jones for having provided information on the Ontario Aerospace Council.

The compilers of this material thoroughly acknowledge Strategis as the primary source of the “Advanced Manufacturing Technologies” and “Aerospace Defence” documents (www.strategis.ic.gc.ca/SSG/bi17983e.html and www.strategis.ic.gc.ca/SSG/bi18072e.html respectively.)

3 Industry Canada **Strategis – Advanced Manufacturing Technologies**

Solutions for Advanced Manufacturing (SAM) is a Web site focused on Advanced Manufacturing Technologies (AMT). The SAM Web site is a subdivision of Strategis and can be found at www.strategis.ic.gc.ca/sam It profiles:

- the supply capability of Canadian AMT companies;
- technology solutions to manufacturing problems;
- related advanced manufacturing information resources.

From the site you will be able to:

- locate Canadian AMT companies and AMT solutions by company name and by the technologies they produce;
- view descriptions of new products and successful implementation of some of these technologies;
- communicate with others in the AMT field through the on-line discussion forum;
- connect with key stakeholders and locate up-to-date information about manufacturing;
- learn about upcoming AMT events;
- search our site to locate an item of interest or to link to other Internet based search tools;

The site is a knowledge and educational tool to inform and educate potential buyers about a broad spectrum of advanced manufacturing technologies serving many industries. It aims to ensure that potential buyers actually learn of the existence of the products, technologies and human resource training available from Canadian firms and institutions, to improve the productivity and profitability of their operations. The site acts as a clearinghouse of information on advanced manufacturing technologies and is an excellent resource for business.

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Introduction

Advanced manufacturing technologies (AMT) are key to creating significant advances in discrete product manufacturing and in resources, primary and other processing applications. They enable firms to more rapidly produce higher-quality, less-costly products with enhanced features. Plants can become more agile, flexible and efficient. Products and systems incorporating AMT are used to enhance design, scheduling, production, storage and distribution activities. AMT are embodied in machine tools; computer-controlled machinery; machine vision systems; robotics; automated production and processing systems; process sensors; and instrumentation and control systems. AMT in the form of industrial software are closely associated with product and process design and control.

Canadian providers of AMT include hardware suppliers who develop technologies and supply products, systems integrators or applications specialists who develop and engineer systems using available components, and software developers of design and control systems. In this report, "AMT suppliers" will include all AMT providers. AMT applications are usually developed in close collaboration with users, providing them with technology solutions to their growth and competitiveness challenges.

The need for AMT solutions appears in most industry sectors. A given technology may be incorporated in widely different and wholly unrelated manufacturing or processing contexts.

New, advanced technology is the key driver for Canadian AMT suppliers. From single-technology, single-sector beginnings, they are able to expand into multiple technologies and sectors, in many different countries.

Canadian Position

The domestic market for AMT is about \$3.6 billion. There are approximately 500 AMT providers in Canada, most of which export. Shipments in 1994 were estimated at \$2.7 billion, of which \$1.9 billion were exported. The United States is the major export market (\$1.4 billion) and also the major source of imports (\$1.8 billion). The sector employs some 16 000 people, including many skilled workers and professionals, and invests 3 percent to 5 percent of its revenues in research and development (R&D). AMT applications are important to most major industry sectors.

The major markets for Canadian products and services are those countries with a modern manufacturing base. Significant opportunities for increased exports exist in the United States, which accounts for about 74 percent of Canadian exports, and in Europe, where manufacturers are investing heavily to upgrade facilities. In general, countries where demand is high include the United Kingdom, Germany, Italy and the Benelux countries. Japan is a large and sophisticated market and is being served by a few Canadian firms, particularly in the areas of robotics and vision systems. China is becoming important for large advanced manufacturing machines.

Excellent opportunities also exist in emerging and developing markets in Southeast Asia and in South America. Countries with potential include Taiwan, Malaysia, Korea, Singapore, Venezuela, Chile, Peru, Brazil and Mexico. In the South Pacific, Australia is an emerging market for Canadian products and services. Saudi Arabia is also beginning to offer opportunities arising from its rapidly growing industrialization program.

Canadian providers of AMT products are generally smaller than their competitors in other countries. The vast majority of Canadian firms are small and medium-sized enterprises (SMEs), with a few large firms having sales up to \$800 million. Growth rates can be high, and are frequently financed from company resources. Continued growth of the AMT sector depends on developing leading-edge products through individual or collaborative research, coupled with market intelligence and aggressive sales efforts in existing and new markets. Building on markets in which Canada already has a perceived superiority can be an important growth factor.

Major groups that make up the small-company AMT population include: early high-technology enterprises; traditional machinery firms evolving into AMT suppliers and systems integrators or applications specialists. Often, their customers are limited in number and defined by geographical or technology application.

Successful Canadian AMT firms, typically those that invest in developing proprietary technologies, tend to sell the bulk of their products in overseas

markets. In fact, Canadian firms often apply their capabilities abroad prior to the Canadian market accepting new technology. Exports include embodied technologies in discrete products, software and integration services, training and servicing. The greatest opportunities for SMEs will be in supplying subsystems and components to suppliers and integrators of more complete manufacturing systems.

Canadian AMT capabilities can benefit a wide range of production-related activities, from discrete part manufacturing to large volume processing.

International Environment

Technology innovation, trade liberalization and the globalization of business are transforming the nature of manufacturing, particularly in such sectors as electronics, aerospace and automotive, which traditionally rely heavily on AMT to maintain their competitive edge. Successful firms in many other sectors are using AMT to introduce new, high-quality products, faster, cheaper, in smaller lot sizes and with more features, for global markets. The use of AMT as an enabling technology is also being seen in non-industrial sectors, such as transportation, power generation and laboratories.

In 1994, worldwide investment in AMT products, services and systems was \$60 billion. It is forecast to be about \$130 billion by the year 2000. North America represents 53 percent and Canada 4 percent of the world market.

Japan, Germany and the United States are leading exporters of AMT products. Japan is a leader in producing machining centres and industrial robots, and has built a strong export machine tool industry. Germany has established a lead in precision machining technologies. The United States dominates the factory systems market, primarily due to its strengths in software and computer hardware development. All three countries are focussing on manufacturing as key to the growth of their economies, and their governments are providing support for the development of AMT. Despite strong competition from these and other AMT producer countries, Canadian firms continue to succeed by focussing on high value-added products, systems integration and niche marketing strategies.

The next generation of manufacturing, referred to as “agile” manufacturing, integrates design, production and inventory control, allowing fast and economic product changes within and between production facilities, and incorporates new information technology applications. The increased use of new materials is forcing the development of advanced processing machinery, particularly in high-volume sectors such as automotive.

Following completion of a two-year feasibility phase, Australia, Canada, Europe, Japan and the United States are co-operating in the Intelligent Manufacturing Systems (IMS) Program. IMS will develop new manufacturing and processing technologies and establish international standards for the next generation of industrial technologies while sharing the costs and risks. Canada hosts the IMS world secretariat until April 1997. Participation in IMS projects is open to technology users and AMT producer firms and to universities and government research institutes.

Main Challenges

125Sector Identity

The AMT sector is neither easily nor well identified. Its economic role and significance are not obviously displayed. Constituent companies are not easily identified, and Canadian AMT strengths not generally well known or broadcast. As an increasingly important activity, the capabilities of Canadian AMT suppliers must be understood, reinforced and promoted, both to meet the challenges posed by competing initiatives in other countries and to exploit Canadian strengths in world markets.

125Market Intelligence

The AMT sector consists primarily of many small firms that are highly dependent on technology and extremely export-oriented. Generally, they lack resources required for extensive market intelligence or for easily taking advantage of foreign business opportunities. To become new exporters or to expand in existing and new markets, they need to connect to specific potential partners and clients. In developing trade opportunities, the search is for customer problems that are amenable to leading-edge technology solutions. Customers may reside in any sector, and possible solutions can often be defined only through on-site consultations. Because Canadian suppliers represent very diverse capabilities, it is difficult to guide foreign representatives abroad toward specific new recipient sectors that would be compatible with Canadian strengths. Considerable exposure to AMT activities is required to identify the most worthwhile opportunities to pursue.

125Domestic Competitiveness

Although it is increasingly important for Canadian manufacturers to be competitive with their U.S. counterparts, the domestic market has been slow to adopt AMT. A contributing factor may be a view held by some that North America is a single market with no significant country or regional differences. Trade in AMT can help to promote domestic competitiveness by identifying and exploiting those opportunities abroad that are applicable to major Canadian markets, such as forestry and wood processing.

4. Market Relevance

For most Canadian AMT firms, the United States is a very important export market with regions of major interest. Canadian companies need to monitor changes, and maintain and enhance their access to this market and to U.S. technology. The significance of other countries is highly dependent upon the technology and applications, which tend to be company specific. Familiarity with the interests of specific companies is the key to assessing their market development stage, identifying potential opportunities and judging their importance to Canadian AMT firms. Structures such as the European Union

Fourth Framework should be exploited to connect Canadian firms more strongly to relevant markets.

125Financing

Difficulties in accessing sources of capital, including equity and bank financing for R&D and for expansion, are ongoing, important challenges. In some cases, R&D tax credits are seen to be positive factors in ensuring that R&D continues in Canada.

125Customer Support

Support and maintenance often represent a challenge for AMT suppliers when customers demand local service support, which smaller firms may find difficult to provide. Many suppliers are moving to remote diagnostics through computer linkages. Some customers, however, such as auto assemblers, need support to all of their production sites around the world.

125Procedure Requirements

Many companies experience hindrances arising from export-import procedures, particularly delays with service personnel crossing the U.S. border.

Strategic Direction

Strategic Objective: To achieve a level of \$4 billion of Canadian AMT shipments to existing and developing Canadian and foreign markets by the year 2000.

Overall Approach: For those new and existing markets identified by the Canadian AMT supplier industry as most relevant to its strengths, improve mechanisms for connecting Canadian capabilities with potential partners and customers, and improve the ease of entry into foreign markets and the conduct of foreign trade for Canadian companies. The following strategies have been formulated to help achieve the objective.

Strategies

- 125Promote the identity of the Canadian AMT industry by distinguishing its characteristics and strengths in terms of know-how, technology and economics, by becoming familiar with and categorizing member companies, and by collating and summarizing AMT industry statistics.
- 125Identify and focus on priority AMT markets abroad and select those for exploitation in relation to Canadian AMT strengths. In particular, find ways to enhance the awareness and understanding of Canada's missions abroad about AMT, and to encourage Canadian companies to take advantage of their capabilities.
- 125Forge linkages between Canadian companies and their markets, by refining intelligence about AMT markets abroad, identifying specific foreign companies and their early requirements related to Canadian technology strengths, and enhancing mechanisms and information avenues for promoting Canadian companies abroad, especially SMEs.
- 125Broaden the scope of the search abroad to include opportunities related to important domestic industry sectors that will help to develop Canadian AMT capabilities for subsequent application in those sectors.
- 125Explore strategic alliances, joint ventures, investment mechanisms and trade structures to help Canadian AMT suppliers participate in foreign markets, and to clarify and reduce hindrances to trade activities that they experienced.
- 125Foster personnel exchanges and collaborative AMT research projects between Canadian AMT companies and foreign companies, universities and technology institutes.
- 125Establish closer links with relevant technology centres and identify technology-sourcing opportunities in important AMT customer markets.

Further Information

Reference material relevant to the sector analysis and the strategy include The Year 2000 Report available through the Manufacturing and Processing Technology Branch (MPT) of Industry Canada, Manufacturing Our Future, September 25, 1995, Canadian Manufacturers' Association and Research Paper Series, Nos. 75, 85 & 86, 1995, Statistics Canada.

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Source: www.strategis.ic.gc.ca/SSG/bi17983e.html

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Introduction

The Canadian aerospace and defence industry is a vital and growing component of our national economy. It is a major contributor to research and development (R&D); employment; national income; exports; national defence; and international prestige. It is also one of Canada's leading advanced-technology sectors, and its innovative products are recognized around the world. It ranks fifth among world exporters of aircraft and aircraft parts, and could well achieve fourth place, if present trends continue. However, the continued growth of the aerospace and defence industry, and its contribution to wealth and job creation in Canada, will depend largely on its ability to capture a growing share of world aerospace and defence markets.

This document defines a three-year strategy (1997-2000) in support of the A&D industry's international business development, and highlights priority activities that will be undertaken during 1997-98.

Economic Contribution

The aerospace and defence sectors together account for some 650 firms and over 57 000 direct jobs.

In 1995, total sales of the industry amounted to \$10.6 billion of which sales to military markets accounted for 24 percent.

Exports represent over 70 percent of the industry's output, and export sales are expected to reach \$8.5 billion in 1996.

Aerospace is the only Canadian advanced technology sector with a consistent record of trade surpluses: in the five years between 1990 and 1994, Canada's cumulative aerospace trade surplus exceeded \$10 billion. Annual R&D expenditures are approaching \$1 billion; investments in machinery and equipment exceed \$350 million.

Sector Definition

The aerospace and defence sector embraces a wide range of associated manufacturing and service subsectors. Table 1 provides an overview of the Canadian product mix for which this strategy was developed.

The sector consists of firms that develop, produce and maintain commercial and military aerospace products, and defence-related products and services for marine- and land-based applications. It includes manufacturers of aircraft, helicopters, aero-engines, simulators, electronics, major systems and components, aviation-security products as well as naval vessels, military vehicles and equipment. It also includes services such as repair and overhaul (R&O), training and aerial fire fighting.

The space industry is a separate subject and therefore, firms that provide space systems such as satellites, ground stations and space-based communications hardware are outside the scope of this report.

Table 1: Canadian Aerospace and Defence Industry – Products & Services

Sub-Sector Aerospace/Defence	Products and Services	
	Civil	Defence
Aircraft - Fixed and Rotary Wing	<ul style="list-style-type: none"> - commuter aircraft and business jets - regional aircraft - amphibious aircraft - helicopters 	<ul style="list-style-type: none"> - airborne surveillance (unmanned)
Aircraft – Structural Components and Systems	<ul style="list-style-type: none"> - Landing gear systems - Landing gear parts and components - Airframe components and structural assemblies for fixed and rotary wing actuators 	<ul style="list-style-type: none"> - airframe systems and components - helicopter parts - helicopter recovery-systems
Aircraft -] Engines and Propulsion Systems	<ul style="list-style-type: none"> - small gas turbine engines - turbofan engines - engine components - engine controls and systems 	<ul style="list-style-type: none"> - small gas turbine engines - engine components
Aircraft – Avionics, Electronics and Electrical Systems	<ul style="list-style-type: none"> - ELTs, flight controls, navigation systems, Environmental control systems, actuating devices, monitor / display devices electric power management and generating systems 	<ul style="list-style-type: none"> - electronic warfare/fire-control systems - cockpit display, navigation equipment - environmental equipment - surveillance and reconnaissance
Simulation, Education and Training Simulation, Education	<ul style="list-style-type: none"> - simulators and training systems - aircraft and flight simulators - Transport Canada's 	<ul style="list-style-type: none"> - simulator and training devices - training programs - pilot training (e.g. NATO)

and Training (Continued)	airworthiness standards - pilot training - airport-management training	
Air-Traffic Control and Air-Navigation Systems	- ATC systems and equipment - ANS installations	- similar/SAMG - ANS installations
Airport and Related Equipment Services	- airfield communications systems - complete airports	- Operations and maintenance services (airfields, air-defence systems)
Services	- aerospace – software - Communications - R&D - project management - project management support services - aerial fire fighting	- Air-traffic control systems - Operations and maintenance services (airfields, air-defence systems) - project management - project-management support services - network-management systems - communications and information-management systems - computer/communication network systems
Repair and Overhaul	- instruments - engines and components - aircraft and components - electrical and electronic equipment	- C130, CP-140 (P-3), Sea King, etc. - F5 refurbish - F18 maintenance - aero-engine R&O - electrical and electronic equipment instruments
Subcontract Services	- machining - plating - heat treating - assembly - electronic assembly - wire and cable assemblies - sheet-metal fabrication - testing and Inspection	- machining - plating - heat treating - assembly - electronic assembly - wire and cable assemblies - sheet-metal fabrication - testing and Inspection

Sub-Sector Defence Only	Products and Services
Defence Electronics, including Marine Equipment	- combat systems integration - radar electro-optics - antisubmarine warfare: sonars, sensors, MSDF and control systems - underwater equipment: sensors, weapons and

	<p>control systems</p> <ul style="list-style-type: none"> - secure computer systems - vessel traffic-management systems - command, control, communications and computer-information systems (C4I) - network-management systems - shipborne systems
Military Vehicles, Components and Systems	<ul style="list-style-type: none"> - light armoured-vehicle family - military wheeled vehicle trailers - vehicle parts and armour - communication antenna - ruggedized computer and communication systems
Marine/Naval	<ul style="list-style-type: none"> - warships (CPF, MCDV, etc.) - small craft (RIBS) - ASW products - underwater vehicles - ship-based systems and equipment
Weapons and Control Systems	<ul style="list-style-type: none"> - air and ground rockets - FCS, turrets, small arms, ammunition, SHORAD, antitank
Defence Security Equipment Airport Security	<ul style="list-style-type: none"> - perimeter-detection systems - security systems - secured computer systems

Canadian Position

World aircraft-production is dominated by large aerospace and defence conglomerates in a small number of large, industrial countries. The United States, the United Kingdom, France and Germany account for over 80 percent of world exports of aerospace products and services. Canada ranks fifth in terms of its world exports.

Primarily a niche supplier, Canada concentrates on regional transports; helicopters; and executive jets; as well as air-traffic control; air-traffic, management systems; simulators; and the infrastructure needed to support these aircraft, in both the aerospace and defence sectors. Canada has world-class expertise in aerospace-related training (commercial and military pilots) and other services, including sophisticated software; aerial firefighting; and R&O. There is also an emerging capability in systems integration, particularly in airport management and security, and defence electronics.

The Canadian defence industry is increasingly developing expertise that meets new defence and peacekeeping requirements. Applications in this area involve security, remote sensing, mine counter-measures (location and clearance) and complex signal analysis. Each of these offers potential in markets that require peacekeeping equipment and services. As the sector moves away from an exclusive reliance on traditional military sales, Canada's marketing of its products must move with it.

Canadian A&D firms have succeeded in establishing themselves as world-class suppliers of several well-known products and services:

- Bell Helicopter now accounts for 50 percent of the civilian helicopter market
- Canadair Challenger supplies 35 percent of the large business jet market
- Pratt & Whitney Canada holds 33 percent of the small gas-turbine market
- de Havilland holds 20 percent of the market for 20- to 70-seat turboprop aircraft
- AlliedSignal supplies 60 percent of all transport-aircraft environmental control systems
- Diesel Division of General Motors of Canada (DDGM) is one of the world's largest suppliers of light armoured vehicles (LAVs)
- Menasco, Messier-Dowty and Heroux collectively hold about 20 percent of the global market for landing gear and 60 percent of the market for new large-aircraft landing gear
- CAE provides 75 percent of the world's commercial simulators and 69 percent of the market for visual simulation
- Med Eng. supplies the best bomb-disposal suits and helmets in the world; it sells to 25 countries, and 75 percent of its total annual sales are exported overseas.

International Environment

Aerospace

The international aerospace industry is highly cyclical. Between the last peak in 1991 and 1995, deliveries of commercial jet aircraft dropped by 40 percent, though they now seem to have bottomed out and are once again increasing.

Worldwide deliveries of new aircraft (i.e. excluding sales of subsystems, subcomponents and parts, and R&O services) are expected to total US\$470 billion in 1996. Sales of commercial-jet transports account for approximately one half of this amount.

The world's total annual spending on aircraft is approximately US\$100 billion. About 47 percent of this is spent on large commercial jet transports, 38 percent on military aircraft, 9 percent on general aviation and 6 percent on regional or commuter aircraft.

Because of its economic attributes and its contribution to national defence and sovereignty, the aerospace industry is considered a strategic sector by governments around the world. Consequently, they are involved in the development of an indigenous industry as owners, financiers and customers of the industry, resulting in excess capacity in some aircraft market segments.

New competitors are emerging from the Asia-Pacific region, where the largest share of air-travel growth is forecast. Nations in this region can often provide lower labour costs and, in some cases, up-front capital that allows them to use their aircraft purchases to lever the establishment of domestic capabilities by the large European and North American original equipment manufacturers (OEMs).

New competitors, which have equivalent technical capabilities to manufacturers in the West but significantly lower labour costs, are also emerging in the Commonwealth of Independent States (CIS) and in Eastern Europe.

There is a move to privatize the provision of services such as the management of airports/facilities and navigation, or the installation and maintenance of traffic-control systems.

Defence

Trade and production in the defence market are heavily influenced by government legislation and procurement practices. As governments are the principal customers in the defence markets, countertrade and offset arrangements are therefore more relevant to this market. Government-to-government agreements and relationships are the key to achieving a larger proportion of this trade.

Governments are now much more active in supporting their defence industries in markets that have become thoroughly globalized.

The global defence industry now operates in a post Cold-War era, characterized by shrinking military budgets and new priorities. New defence doctrines and the changing nature of threats and conflicts in today's political environment call for new approaches and different solutions.

There is a noticeable trend toward extending the operational life of major military equipment.

Affordability will dominate purchasing decisions and tender specifications will be increasingly tailored to what is commercially available off-the-shelf.

Market Outlook

Aerospace

A strong recovery in the world aircraft-market is forecast over the period. For example, the current market forecast prepared by Boeing for the period 1996-2015 suggests that worldwide, economic growth will average 3.2 percent per year. Growth in air traffic will average 5.1 percent per year, with the strongest growth occurring in the Asia-Pacific region. Growth in China is expected to reach 11.5 percent per year. Growth in air-cargo traffic will average 6.7 percent per year; the global air fleet will consist of 23 080 passenger- and cargo-jet aircraft by the year 2015. This implies that approximately 15 900 new aircraft will be purchased over the coming two decades at an equivalent of \$1.1 trillion in 1995 U.S. dollars; and the fastest-growing segment of the market will be that of intermediate-sized planes.

These projections suggest major opportunities, both for primes and for parts and service suppliers in Canada. Growth is also envisaged for Canadian suppliers of proprietary products and services, especially for commuter and regional aircraft;

helicopters; and gas turbine engines. By extension, demand for related parts, subsystems and services will be stimulated. However, companies with a simple build-to-print capability will be in a more vulnerable position as competitive pressures from suppliers in Asia and Eastern Europe intensify.

The following are examples of major new programs

- PRC/Europe/Singapore AE100
- Bombardier CRJX
- AIR new regional liner
- Airbus Industry A3XX
- IPTN regional jetliner.

Some of these programs may offer opportunities for participation by Canadian firms. As aircraft manufacturers define much larger, integrated systems-packages and increasingly source these systems globally, opportunities for Canadian firms to act as direct suppliers may be reduced, challenging them to initiate and build new relationships with the global partners of aircraft manufacturers.

Defence

New market opportunities will develop as the military focus shifts from the military to non-traditional roles. Companies that can offer either cost-saving technology such as simulation systems, or products and services for extending the operational life of existing equipment, will be in demand. Firms that concentrate on producing traditional hardware such as warships, will face some difficulties; they will increasingly have to shift to dual-use technologies and/or commercial markets to maintain business levels.

Europe will tend to become one integrated market characterized by consolidated development and procurement of armaments and military equipment.

The United States still maintains global interests but its defence budget has leveled out at about US\$170 billion per year (operation and maintenance [O&M], procurement, and research, development, testing and evaluation [RDT&E]) after declining for several years. Canada currently supplies approximately \$1 billion, or one half of one percent of U.S. defence-procurement through its international contracting agency, the Canadian Commercial Corporation (CCC), under the terms of the joint U.S./Canadian Defence Production Sharing Agreement (DPSA).

A number of East Asian countries such as China, Japan, India, Korea, Taiwan and the Philippines offer potential markets for Canadian defence products, particularly in the area of security systems.

Market Types

The distinctive characteristics of different segments of the global market for A&D products and services have a significant impact on how the markets are to be approached. These factors are recognized in the strategy articulated by industry and government.

Traditional markets such as Europe or the United States are characterized by stability in terms of new purchases and well-established competition. Fast-growth markets (e.g. Southeast Asia and the Pacific Rim) are experiencing increased air

traffic, and thus will need more aircraft and an expanded infrastructure.

Emerging markets such as Latin America, the CIS or Eastern Europe, are those in which the countries' economic development creates new needs. Such markets may require early involvement, investment to demonstrate goodwill, or a watching brief to develop a position for the future.

Even within the same market, the nature of opportunities differs. While there is some movement and overlap between the proposed market segmentation outlined below, this approach offers a sound framework for developing market research and an action plan for the Canadian A&D industry.

Following are the proposed market segment descriptions:

Program-driven opportunities emerge from the major new or derivative aircraft platform programs (civil or defence) which are being contemplated. Positioning Canadian industry for program-driven markets requires:

- timely knowledge of major platform programs and needs, such as the development of new aircraft, helicopters, engines, etc.
- getting in on the ground floor as a direct supplier of services and products to the builder/contractor, or joining as a member of a team along with suppliers that are already known to the builder/contractor
- active participation by primes in gathering timely knowledge and promoting involvement.

Purchase-driven market opportunities are characterized by the ongoing need for product support in areas such as R&O, or the provision of non-proprietary products (e.g. standard components) and services (e.g. training). Positioning Canadian industry for purchase-driven markets requires:

- identification of purchases that match Canadian capabilities (e.g. in overhaul, defence, etc.);
- knowledge of the competition;
- knowledge of relevant regulations, customs clearance issues and NTBs that can affect the outcome

- participation by missions and industry to identify market opportunities and requirements.

Geographic market-driven opportunities are connected to large procurement contracts and/or infrastructure expansion linked to long-term needs or structural changes. Examples include the construction of airports and related support

equipment and services, or new requirements for security as a by-product of economic growth. Positioning Canadian industry for geographic markets requires:

- knowledge of emerging opportunities, including spin-off activities generated by major procurement contracts or infrastructure expansion
- an analysis of these opportunities to match them to Canadian capabilities
- active participation by missions and the Department of Foreign Affairs and International Trade (DFAIT) in identifying opportunities and linking to Canadian capabilities

Determining which markets are priorities involves intelligence gathering and the development of an understanding of market dynamics. Ultimately, an opportunity matrix will be developed that aligns different market and opportunity types with Canadian capabilities and that point to a positioning strategy for specific opportunities or specific countries.

Main Challenges for Canadian Industry

International Trade and Business Environment Challenges

Market access is a major issue for Canadian firms, since trade and production are heavily influenced by non-tariff barriers (NTBs) such as set-asides and industrial offset policies, particularly in the military aircraft market.

Many of Canada's foreign competitors are effective in leveraging the international commitments of their governments in areas of defence or international development.

Structural Challenges

Relationships among companies are changing, as firms at every level of the supply chain demand that their subcontractors and system suppliers shoulder more development costs and risks, or provide complete subsystems.

Customers are placing a greater emphasis on "full service" packages that include training and after-sales support.

Product development is increasingly focussed on reducing the design and production times, as well as operating costs, associated with A&D products.

Business-to-business relationships are increasing in complexity. They require considerable sophistication in terms of the application of electronic data interchange (EDI), innovative financing techniques and technical expertise.

With the exception of the very largest primes (Bombardier, Pratt & Whitney Canada and Bell), most Canadian firms are small by international standards and often lack the financial and technical resources to compete successfully in this type of environment. Few of them can offer the comprehensive capabilities now required by customers, and few have the breadth to bid on major offshore systems without foreign partnering. Yet the level of inter-firm co-operation in Canada lags behind that in competitor countries.

International Marketing Challenges

Canadian firms face additional challenges in marketing internationally, given their relatively small size. For example:

- The penetration of foreign markets can be extremely costly
- It may be difficult to obtain timely and appropriate information and intelligence on foreign markets
- The need for insights into foreign cultural and business practices may require high-quality foreign representation in the form of agents, alliance partners or key contacts

- Canadian firms may find it difficult to arrange for export financing that can compete with the terms offered by foreign organizations.

Defence-specific Challenges

As a result of the link to national security and the control of advanced technologies, partnering between governments and the defence sector is often mandatory.

More attention is being paid to price and competitiveness in defence procurement: technical performance and top quality alone are no longer enough.

There is an increased emphasis on low-cost solutions and the need to reduce the life-cycle costs of military systems.

Declining defence budgets will lead to stronger protectionist pressures.

The industry supports the Canadian defence exports-permits policy that reflects this country's policy on international human rights. However, changing interpretations of Canada's export-control regulations make it difficult for our aerospace and defence industry to plan ahead or to commit to some major international tenders.

Strategic Priorities for 1997-99

Work will proceed over a three-year period on all six strategic thrusts. During 1997-98, particular emphasis will be placed on the following priorities in the context of the market segments identified earlier.

Strategic Priorities for 1997-99

Strategic Thrusts	Program-driven	Purchase-driven	Geographic market driven
Market Access	Support by embassies and CFAs	Acceptance of Transport Canada standards	Customs clearances: Access to United States and Russia
Enhanced SME Support	Capability database	Capability database, reduced turnaround times and enhanced EDI capability	Capability database Seminars on aerospace training issues
Teaming and partnering	Opportunity-driven system teams Airshow Canada SubCon	Opportunity-driven full capability set Airshow Canada SubCon	Opportunity-driven alliances and teams Airshow Canada SubCon ATCI
Market Intelligence and Information	Gather, analyze and disseminate program and analysis of emerging programs		Identification of infrastructure projects and dissemination mechanism
Flagship Presence (All Identified air shows, Team Canada missions)	Airshow Canada APEC Team Canada SubCon	Presence of CPF Airshow Canada APEC, Team Canada, SubCon	Airshow Canada APEC, Team Canada, SubCon, ATCI missions

Program-driven Opportunities

Market Intelligence: Exploiting opportunities in program-driven markets depends on a comprehensive and current knowledge base of major emerging programs. Government and industry will co-operate to establish a mechanism and process to identify the scale and scope of emerging programs. This information will be used to match Canadian capabilities with specific opportunities and to develop an appropriate positioning strategy.

Teaming and Partnering: Taking the lead from identified program opportunities, efforts will be made to establish opportunity-driven alliances and teams that will enhance Canada's ability to respond to the increasing demand for complete subsystems. This effort will be augmented by the development of flexible networks, increased preparation of SMEs, and enhanced linkages/mentoring between key companies and suppliers.

Purchase-driven Opportunities

Market Access: Enhance market access through greater global acceptance of TC airworthiness standards. Bridging the gap between customer perceptions and reality will form the initial element of a longer-term effort to use Transport Canada's high standards for safety and security as a competitive discriminator in world markets.

Enhanced SME Support: Improve R&O turnaround times. Efforts will focus on mechanisms to reduce customs-clearance paperwork and delays, to minimize the impact of policy changes, and to develop greater company capabilities in the area of EDI.

Teaming and Partnering: Establish opportunity-driven alliances and teams to meet customer demands for service providers with a "full capability set."

Geographic Market-driven Opportunities

Market Access: Identify in a timely manner, aviation infrastructure projects that match Canadian capabilities. This will be accompanied by the development of an appropriate and ongoing mechanism for acquiring and disseminating timely information and intelligence on emerging projects around the world.

Teaming and Partnering: Establish opportunity-driven alliances and teams to identify possible linkages within the sector and with other sectors such as consulting engineering and construction.

All Opportunities

Enhanced SME Support: Link customer needs with the capabilities of Canadian aerospace SMEs. As yet, there is no current, comprehensive and convenient knowledge base of these capabilities, which could be an effective sourcing tool for buyers, partners etc. The focus for 1997-98 will be to build on existing databases as a first step in expanding capabilities and establishing new alliances and teams.

Flagship Presence: Create a strong Canadian government presence in Airshow Canada 1997 by co-ordinating a Canadian-government presence, actively supporting the industry's strategic planning and assisting in the recruitment of buyers from around the world in accordance to Canadian exhibitors' capabilities

1997-2000: A Vision for Canada's Aerospace and Defence Industry

The A&D International Business Strategy aims to increase the Canadian industry's share of world markets by:

- pursuing selected international markets offering profitable opportunities that correspond to Canadian service and product strength
- increasing the market share of firms already exporting in this sector; and
- increasing the number of firms exporting in this sector by promoting Canadian world-class capabilities in specialized or new market niches.

To achieve these aims, industry and government have articulated a framework of six elements, which form the basis of a three-year strategy. This strategic framework and the market-segmentation approach that was developed will help the National Sector Team (NST) and the missions to better focus and leverage their efforts to achieve maximum results.

Overview of the Strategic Framework for Aerospace and Defence 1997-2000

Level	Strategic Framework	Priority Actions
<p>International Trade Environment (where government involvement is a requirement) Objective: To achieve more favourable international business climate for Canadian A&D firms</p>	<p>1. Policy, Legislation and Market Access</p> <p>2. Endorsement, Leverage and Advocacy</p>	<ul style="list-style-type: none"> - Gather Intelligence on NTBs and participate in international negotiations - Monitor procurement practices - Reinforce DDSA/DPSA TC/FAA standards - Customs clearances - Strengthen monitoring of bid requirements; support of Canadian bidders rights - Represent industry re: "right to bid" - Endorse Canadian products used by Canadian government - Leverage Canadian participation in international initiatives
<p>Structural (where industry and government work together to enhance export capabilities of firms) Objective: To achieve greater SME participation in world markets</p>	<p>3. Enhanced Canadian SME export capability:</p> <ul style="list-style-type: none"> - export preparation - access to resources <p>4. Teaming/ business networks</p>	<ul style="list-style-type: none"> - Increase use of existing training and information sites and How to Outreach Seminars (both civil and defence) on market awareness - Promote existing domestic financing sources - Target incoming and outgoing missions - Target participation in air shows - Target and work with SMEs to develop international market potential - Promote flexible networks concept; train brokers, conduct seminars - Form networks and alliances within Canada and with foreign firms - Promote supplier-to-supplier relationships as means of reaching foreign and domestic exporting primes
<p>International Marketing (where government and industry work in partnership to enhance export initiatives abroad) Objective: To achieve greater impact in target countries</p>	<p>5. Market intelligence and information</p> <p>6. Flagship presence</p>	<ul style="list-style-type: none"> - Identify intelligence needs and ensure timely and targeted dissemination - Strategic involvement of CFAs - Develop strategies on geographic (or sub-sector) basis - Work with industry to develop better market intelligence on major programs - Strategic participation/visibility in events/countries - Team Canada Aerospace and Defence activities - Air shows including Airshow Canada, participation in APEC

Strategic Framework

International Trade Environment – Policy, Legislation and Market Access

Industry and government will continue to work toward the elimination of NTBs such as some standards (work rules), testing and certification requirements.

This will require better knowledge of such barriers together with concerted action within the appropriate international frameworks such as the Agreement on Trade in Civil Aircraft in the World Trade Organization (WTO), and the Organization for Economic Co-operation and Development (OECD) consensus arrangements to limit government-assisted financing for civil-aircraft sales.

Activities will focus on efforts to:

- promote harmonization of standards
- achieve global acceptance of Canadian airworthiness standards, i.e. Transport Canada (TC)
- reduce impediments to licensing and transferability of personnel between company sites in different countries
- monitor developments that may affect Canadian aerospace and defence trade, including international subsidy programs, environmental regulations, NTBs, and laws affecting aerospace and defence products and services
- increase promotion and use of Defence Development Sharing Agreement / Defence Production Sharing Agreement (DDSA/DPSA) as a means of enhancing market access
- achieve reciprocity for Canadian bidders, where there is a memorandum of understanding (MOU) or RDP agreement
- where no MOU exists, support Canadian firms' right to bid under WTO rules
- facilitate access for Canadian firms to the North American industrial technology base and to the markets of NATO (North Atlantic Treaty Organization) allies by representations to decision makers in those markets on the basis of examples of restricted access provided by industry.

International Trade Environment – Endorsement, Leverage and Advocacy

Canada's competitors are heavily supported by their governments through a strong political presence and the endorsement of products. Enhancing Canada's advocacy, endorsement and leverage abroad will involve:

- collaboration among firms, industry associations and the Canadian government, which, through the Department of National Defence, is a purchaser of defence products: the objective of this co-operation should be to promote Canadian

- defence products in export markets, for example through activities such as frigate visits
- advocacy and endorsement of Canadian firms, products and services by high-level officials such as the Prime Minister, other ministers, our ambassadors and others
- working with the Canadian International Development Agency (CIDA) to increase the leverage of Canadian initiatives abroad.

Structural – Enhanced SME Support

Canada must expand the number of export-ready firms, particularly in niche areas in which we have leading-edge capabilities and evident, international growth-potential. To achieve this, the NST and International Trade Centre (ITC) account executives will target aerospace and defence small and medium-sized enterprises (SMEs) that are either new to exporting or have the potential to upgrade their ability to address new foreign markets. A concerted effort will be made to:

- provide enhanced, export preparation through workshops and strategic-planning assistance
- encourage SMEs to enter into partnerships with key companies and suppliers in domestic and international markets
- promote mentoring by experienced exporters that might assist new or smaller exporters by sharing information on markets, business practices and agents, or by helping them to participate in trade shows
- disseminate information on non-conventional and new sources of financing available to A&D firms
- present and promote more forcefully the interests and importance of A&D firms to financial institutions, particularly with regard to large risk-sharing programs. The support available through CCC, EDC (Export Development Corporation) and the Business Development Bank of Canada (BDBC) will also be further developed
- maximize use of incoming missions such as the Airbus mission, the Asia-Pacific Economic Cooperation (APEC) forum and Airshow Canada, as a lower-cost means of promoting Canadian capabilities to foreign firms
- strategically plan outgoing missions that fit with an overall country or subsector strategy, or tie into participation in major trade shows
- promote industry (SME) capabilities through state-of-the-art information tools such as the World Wide Web and electronic conferencing.

Structural – Teaming and Strategic Partnerships

Business networking and partnering will be promoted within the industry. Efforts will also be made to encourage and broker strategic alliances among Canadian SMEs, and between Canadian companies and foreign firms that can provide financial, technological and marketing resources. Both of these thrusts will be led by Industry Canada, teaming with other departments, Aerospace Training Canada International (ATCI), industry associations and the provinces. This will be achieved through:

- workshops on flexible business networks by associations, provinces and agencies
- training of specialized A&D agents by the associations, provinces and agencies
- co-operation among missions, associations and key companies to identify prospects for partnership in targeted markets (e.g. partnering with Australian firms can help penetrate Australia, New Zealand and the Asia-Pacific countries);
- promotion of partnerships with subcontractors to major key companies in traditional markets and with subcontractors and suppliers on major programs (e.g. Boeing suppliers)
- reinforcement or development of MOUs with target countries
- linkages with Technology Partnership Canada
- promotion of Canadian training partnerships through Aerospace Training Canada International.

International Marketing – Market Intelligence and Information

Two NST working groups were created to identify promising international opportunities within the program-driven, purchase-driven and geographic market-driven segments. These working groups include industry, DFAIT geographic representatives and members of the NST.

Focussing on the program-driven segment, the Major Programs Working Group will work on identifying and monitoring:

- major new aircraft and derivative programs that provide opportunities for Canadian suppliers
- competitor activity
- opportunities for partnerships and collaboration
- changes in government policy, legislation and access issues.

The Group will also define and establish ongoing mechanisms for monitoring, analyzing and disseminating information about major programs.

Focussing on purchase-driven and geographic market-driven segments, the Market Intelligence and Information (MII) Working Group will focus on:

- prioritizing the type of intelligence required and information gaps, (e.g. studies, updated market reports and subsector studies), based on industry needs and capabilities
- providing an analysis of the opportunities and linking these opportunities to Canadian strengths
- enhancing dissemination of the information to the relevant individuals and firms, including increased use of the NST as an information-sharing forum.

Missions will participate in these groups and/or assist in these efforts by:

- monitoring the status of major foreign programs or procurement opportunities for which Canadian firms might be eligible
- obtaining early notice of impending contracts and challenging defence procurements that are designated as “national” sources only
- reporting on all significant A&D contracts expected in a country of accreditation, no later than six months in advance
- undertaking studies in priority countries to identify niche-sector opportunities
- updating existing or developing new baseline-studies for emerging markets
- strengthening target-country intelligence-gathering capability and enhancing linkages to activities in Canada
- identifying vetted agents/local representatives abroad for use by Canadian firms
- facilitating access to knowledge of Canadian firms by trade commissioners and Canadian Forces attaches.

Flagship/Team Canada Presence

A concerted effort will be made to create a visible Canadian flagship (Team Canada) presence for aerospace and defence firms in selected countries, through targeted and enhanced NST participation in selected air shows and events, and a co-ordinated participation in the Team Canada missions abroad (e.g. representation by major departments, agencies or provincial governments). This does not exclude normal participation in and support of traditional air shows, which offer opportunities for Canadian firms.

Canada will focus primarily on the following activities:

- supporting Airshow Canada to enhance Canadian SME visibility with foreign buyers
- participating in APEC activities to promote Canadian SMEs and develop business opportunities in Asia-Pacific markets, particularly in the context of Canada's role as host of the APEC conference in Vancouver in 1997

- co-ordinating participation in key established international trade shows (e.g. Paris, Farnborough and Asian Aerospace) and selected emerging air shows such as FIDAE in Chile and LIMA in Malaysia, in which Canadian firms have already established a solid reputation or are making inroads, and there is a requirement for continuity and high-level visibility
- Team Canada missions led by the Prime Minister and/or by Cabinet ministers,
DND senior officials, as well as other senior provincial-government officials.

Priority Markets

Opportunities exist in almost every market on a global basis. They depend on local infrastructure requirements, demand for maintenance and services, or simply the announcement of major new programs. It is difficult to define priority countries without reference to these factors.

Strategic opportunities may exist within a specific project in a country, even though the country itself is not necessarily a priority market. That strategic opportunity will require the same enhanced level of service accorded to priority markets.

Establishing priority markets for A&D, therefore, requires ongoing analysis to determine the existence of the most promising opportunities. Specific opportunities must be identified, not just target countries. The countries identified below have the most promise to offer, from a geographic perspective.

Country Assessments

Industry has identified a number of priority markets. The largest of these is the United States, which is the prime market for most Canadian firms. On the commercial side, Canadian suppliers have an opportunity to expand their sales to key companies such as Boeing and MacDonnell Douglas, primarily by using teaming arrangements.

The United States purchases 80 percent of Canada's defence exports, although this represents only 0.5 percent of all U.S. Department of Defence procurement. A small increase to 1 percent would be worth a sum equal to the value of all the contracts that the rest of the world awards to Canadian firms. In addition, the U.S. concern for aviation security represents approximately US\$13 billion to upgrade aviation security. Canadian firms have excellent world-class capabilities in this domain.

Europe is the world's second-largest defence market, but changes in the European Union will make it harder for Canadian suppliers to access it. While the complexity of European rules and regulations may appear to make that market impenetrable, many European firms are interested in doing business with North American firms to take advantage of lower U.S. labour costs. Selected major programs in Europe also represent potential opportunities for Canadian firms. The most important European markets are to be found in the United Kingdom, France, Germany, Italy and Greece.

In addition, the expansion of NATO may stimulate demand that could be addressed by strong niche players working with strategic partners. Canadian firms could take advantage of this by offering specialized products and services such as NATO flight training.

The Asia-Pacific and Southeast Asia regions are especially promising because of the rapid economic growth expected throughout these regions. Growth, however, will attract intense competition while simultaneously creating the desire in these

countries to establish their own indigenous industries and capabilities.

Despite these challenges, however, Canadian firms have established a good reputation in target countries such as Malaysia, Singapore, India, China, Thailand, the Philippines and South Korea. Australia offers attractive partnering opportunities given the upcoming Olympics 2000. The whole region needs infrastructure development (airports, air traffic control equipment, training of pilots and airport management) to service the rapid growth in air traffic.

A number of East Asian countries such as China, Japan, India, South Korea, Taiwan and the Philippines offer potential for Canadian defence products, particularly in the area of security systems. Australia offers important opportunities for defence, particularly in the area of defence communications, in addition to good prospects for the development of strategic alliances aimed at penetrating markets in Southeast Asia.

Latin America presents important opportunities in both the aerospace and defence industries. Countries such as Chile, Argentina, Mexico and Peru represent emerging markets that require strategic positioning by Canada and Canadian A&D firms, especially in terms of follow-up to the success of Canadian participation at FIDAE '96.

The Middle East remains an important market, particularly for defence-security firms and for some commercial products. The region accounts for more than 40 percent of all defence-product transfers and is expected to absorb over \$150 billion by the year 2000. Saudi Arabia is expected to purchase \$32 billion worth of military equipment, and other targets include the United Arab Emirates and Kuwait. Endorsement and advocacy are key to success here.

Emerging markets

Most countries in the CIS (e.g. Russia) and Eastern Europe (e.g. Romania) offer limited immediate opportunities for firms other than Canadian key companies. However, while these markets require long-term investment and know-how, as well as a willingness to transfer technology, it is important for the Canadian industry to immediately position itself for the future. Market access in most of these countries remains a challenge.

Africa offers potential in a number of aerospace niches such as airport upgrades and air-traffic control, which is particularly suitable for some small Canadian firms.

A summary of target markets is as follows:

United States	Malaysia	Chile
United Kingdom	Singapore	Argentina
France	China	Mexico
Italy	Thailand	Germany
Philippines	Saudi Arabia	Greece
South Korea	Japan	United Arab Emirates
Australia	Kuwait	India

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Sources www.strategis.ic.gc.ca/SSG/bi18072e.html

Appendix 1 – Federal Organizations

Canadian International Business Strategy
Industry Canada
Strategis
National Research Council
National Research Council - Institute for Aerospace Research

Appendix 2 – Other Provincially or Federally Supported Organizations

Other	Natural Sciences & Engineering Research Council of Canada Canadian Technology Network
Manufacturing	Alberta Research Council Centre Prototech / Prototech Centre Centre de recherche industrielle du Québec (CRIQ) Inforex InNOVAcorp Materials and Manufacturing Ontario (MMO)
Aerospace	Aerospace Industries Association of Canada The Canadian Aeronautics and Space Institute Canadian Space Agency Center for Technologies in Aerospace (CTA) Centre for Research in Earth and Space Technology

Appendix 3 – Trade Associations

Alliance of Manufacturers and Exporters Canada
Automotive Parts Manufacturers' Association
Canadian Advanced Technology Association
Canadian Association of Mining Equipment and Services for Export
Canadian Association of Moldmakers (CAMM)
Canadian Plastics Industry Association
Canadian Tooling & Machining Association
Electro-Federation Canada
Industrial Research+Development Institute (IRDI)
Machinery & Equipment Manufacturers' Association of Canada

Appendix 4 – University Activities

Manufacturing	
Aerospace	Carleton University McGill University University of Toronto - Institute for Aerospace Studies

Appendix 5 – Companies

Advanced Manufacturing - Companies
Companies – Aerospace

Appendix 1 – Federal Organizations

Canadian International Business Strategy

Canada's International Business Strategy (CIBS) sets out the international business development strategies for 27 industry sectors.

CIBS is an integral part of the federal government's international business development efforts, and is a vehicle through which Canadian companies can begin or expand their exporting efforts. Through direct and active consultation between governments and the private sector, CIBS provides Canadian industry with a real opportunity to influence the government's international business strategies and priorities. At the same time, CIBS works to streamline the allocation of resources and to rationalize federal (and increasingly provincial) international initiatives. CIBS will also play an important role in the government's first commitment to departmental sustainable development (SD) strategies. As it prepares its SD strategy, the Department of Foreign Affairs and International Trade (DFAIT) will look at ways to help Canadian exporters — SMEs in particular — to better understand and respond to new environmental imperatives, and to ensure continued access to key export markets.

Strategies that have the greatest chance of success are those that are developed by federal and provincial governments in close collaboration with industry. They must reflect industry's priorities, and incorporate a careful assessment of Canadian strengths and worldwide opportunities. The sector strategies are the basis upon which the federal and provincial governments will allocate a considerable portion of their international business development resources. Each strategy identifies the primary objectives that government and industry will pursue to help Canadian firms capture emerging global trade, technology and investment opportunities. These objectives, in turn, determine which specific international events and initiatives receive government support.

Individual sector strategies are the product of National Sector Teams (NSTs), groups that bring both private- and public-sector expertise to bear on a range of business issues. NST involvement in the development of CIBS ensures that government initiatives reflect the real needs of Canadian industry. By co-ordinating federal, provincial and industry planning, CIBS reduces overlap and duplication, and directs government resources where they can genuinely make a difference.

CIBS includes:

Volume 1, the CIBS Overview, consists of two parts: a *Strategic Overview* summarizing Canada's main international business development and trade policy objectives; and a *Geographic Overview* identifying key challenges, priorities and opportunities within each of the world's major geographic regions. Also included is a complete list of Canada's International Trade Centres, from which firms can obtain a variety of services related to doing business abroad.

Volume 2, Industry Sector Strategies, sets forth the main challenges identified by the NSTs in pursuing international business opportunities, and the strategic directions that government and industry will follow for emerging global trade, technology and investment opportunities. The full text of each strategy, including a brief profile of Canadian capabilities and a snapshot of the international market, is available in electronic format or by fax.

The CIBS Compendium — International Activities: Federal and provincial governments have agreed to use the sector strategies as a basis for the allocation of resources. A continually updated list of activities designed to implement the sector strategies — known as the evergreen CIBS Compendium — is posted on the Internet. Canadian companies are invited to participate in these events, and are encouraged to contact the department or agency listed for details.

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Industry Canada

Industry Canada maintains a website at www.info.ic.gc.ca

Industry Canada's mission is to foster a growing competitive, knowledge-based Canadian economy. The department works with Canadians throughout the economy and in all parts of the country to improve conditions for investment, improve Canada's innovation performance, increase Canada's share of global trade and build a fair, efficient and competitive marketplace. Program areas include developing industry and technology capability, fostering scientific research, setting telecommunications policy, promoting investment and trade, promoting tourism and small business development, and setting rules and services that support the effective operation of the marketplace.

Strategis

Launched in 1996 by Industry Canada, Strategis provides direct access to valuable business and consumer information resources, interactive tools, and a growing number of on-line and electronic commerce services. Industry Canada promotes international competitiveness and sustainable growth. To accomplish this, it gathers and analyzes business intelligence, develops strategic analyses aimed at specific subsectors, ensures that long-term development opportunities for Canadian firms are optimized through major Crown procurement projects and develops business intelligence information products.

Industry Canada, a department of the federal government, employs over 4,000 people across Canada. Its employees are analysts, engineers, economists, trade officers – with personal and in-depth knowledge of industry; they are experts at finding, collecting and analyzing information. Their contacts act as a network of information resources, including trade commissioners in Canadian embassies around the world, business experts in major organizations and researchers in international think tanks.

Strategis is Canada's most comprehensive Internet site for Canadian businesses and consumers, allowing visitors to identify new markets, find business partners, form alliances, locate emerging technologies or processes, and assess various risk factors. This strategic business information helps create new business opportunities, new jobs and renewed growth.

Strategis fits squarely into the Canadian government's goal to make Canada a leading "connected" nation. The strategy lays the groundwork for Canada to become a world leader in developing and using Internet and communications technologies. Our country's economic performance and social goals are tightly linked to our ability to access the proper information at the right time. This site is the manifestation of the goal to make it easier for Canadians to profit from a sound business climate.

Strategis can be found at www.strategis.ic.gc.ca

National Research Council

The NRC maintains a website at www.nrc.ca

The National Research Council of Canada (NRC) is the nation's leading research organization, focusing on R&D in biotechnology, information & telecommunications, and manufacturing technologies as well as the construction, marine and aerospace sectors.

History

The National Research Council of Canada has been the country's leading R&D organization for over 81 years. Established in 1916, NRC functioned mainly as an advisory body to government until the early 1930s when new laboratories were established in Ottawa. During the Second World War, NRC grew rapidly as it performed R&D to benefit the Allied effort. NRC was a prime player during the explosion of basic and applied research in science and engineering in the 1950s and 1960s, and played an important role in research focussed on helping industry during the 1970s and 1980s. From the mid-1980s, NRC has placed greater emphasis on partnerships and strategic contributions to technological advancement and wealth creation.

Over the years, a number of specialized agencies and services have grown out of NRC, including the Defence Research Board, the National Science Library, the Medical Research Council, the Natural Sciences and Engineering Research Council, Atomic Energy Canada Ltd., and the Canadian Space Agency.

Association with Government

NRC is an agency of the Government of Canada, reporting to Parliament through the Minister of Industry. It is governed by a council of 22 appointees drawn from its client community. NRC's mission is to support national science and engineering activities, perform and stimulate investment in research to develop vital expertise and knowledge. NRC's annual budget is about CA \$400 million with an annual income of roughly CA \$60 million. The organization has a highly skilled work force of 3 000 plus 730 guest workers.

NRC's research institutes and technology centres, located from coast to coast, have national mandates but are integrated regionally. They work with Canadian industry through collaborative research, consortia, special interest groups, and facility-based partnerships.

Activities

NRC facilities and programs are accessed daily across Canada and around the world. Thousands of scientists, engineers and research organizations are served by NRC's Canada Institute for Scientific and Technical Information (CISTI), which offers one of the world's largest collections of scientific, technical and medical information, and NRC Research Press, Canada's leading publisher of scientific **journals. Many Canadian firms find technology solutions through NRC's Industrial Research Assistance Program (IRAP), and the Canadian Technology Network (CTN).**

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National Research Council - Institute for Aerospace Research

This organization maintains a website at <http://www.nrc.ca/iar/index.html>

As Canada's national aerospace laboratory, NRC's Institute for Aerospace Research (IAR) undertakes and promotes research and development in support of the Canadian aerospace community, in matters affecting the design, manufacture, performance, use and safety of aerospace vehicles.

NRC serves the industrial needs of airframe manufacturers, avionics manufacturers, and aircraft operators. Aerospace manufacturing requires fundamental design assurances for its structural parts that encompass fail-safe and damage-tolerance concepts. IAR research and testing helps clients to meet these standards and satisfy airworthiness and certification requirements.

IAR maintains expertise in and operates national facilities for:

- aerodynamics testing**
- structures and materials research**
- aeroacoustic research**
- flight testing**
- airborne simulation**
- airborne sensing**
- aeropropulsion research**
- icing research**
- materials processing**
- advanced manufacturing**
- non-destructive testing**
- diagnostic testing**

Research is conducted in three laboratories:

- The Aerodynamics Laboratory**
- The Structures, Materials & Propulsion Laboratory**
- The Flight Research Laboratory**

IAR facilities include seven wind tunnels, air compressor/exhauster facilities, engine test cells, a full-scale structural fatigue rig, aeroacoustics chambers, a Flight Data Recorder Playback Centre, and a fleet of eight research aircraft.

Contact

**Catherine Betz, Communications Officer
National Research Council Canada - Institute for Aerospace Research
Montreal Road
Ottawa, Ontario, Canada K1A 0R6
Phone: (613) 991-6915**

Fax:

(613)

952-7214

Appendix 2 – Other Provincially or Federally Supported Organizations

Natural Sciences and Engineering Research Council of Canada
The NSERC maintains a website at www.nserc.ca

NSERC (the Natural Sciences and Engineering Research Council of Canada) is the national instrument for making strategic investments in Canada's capability in science and technology. NSERC supports both basic university research through grants and project research through partnerships of universities with industry, as well as the advanced training of highly qualified people in both areas:

- more than 9000 students are supported in their advanced studies
- 8700 researchers are funded every year
- more than 1,000 Canadian companies to invest in university research.

In 1999-2000, NSERC will invest \$538 million in university-based research and training in all the natural sciences and engineering.

NSERC is a separate employer of the Government of Canada, reporting to Parliament through the Minister of Industry. It is governed by a Council of 22 members selected from the private and public sectors, and the universities.

Mission

The Natural Sciences and Engineering Research Council fosters the discovery and application of knowledge through the support of university research and the training of scientists and engineers. The Council promotes the use of this knowledge to build a strong national economy and improve the quality of life of all Canadians.

NSERC fulfills its mission by awarding grants and scholarships through a competitive process and by building partnerships among universities, governments and the private sector.

NSERC's History

NSERC came into existence May 1, 1978. University-based research had previously been supported through the National Research Council. NSERC has grown from a budget of \$112 million to a budget of \$538 million.

Contact

NSERC
350 Albert Street
Ottawa, Ontario
K1A 1H5

Telephone: (613) 995-5992

Facsimile: (613) 992-5337

Canadian Technology Network

The CTN maintains a website at www.nrc.ca/ctn/ctn.html

The Canadian Technology Network links federal and provincial government labs and agencies, universities, community colleges, industry associations, technology centres and economic development agencies. Together these organizations provide Canadian companies with access to expertise, advice and information about how to meet technology and related business challenges.

CTN provides a wide variety of information, including:

1. Profiles of organizations doing ground breaking work in the technology sector.
2. Profiles of organizations that offer business-related services such as financial, management, marketing and training.
3. The names and address of experts in a wide variety of technological fields.
4. Offers of technology and service profiles from more than 30 technology-related business sectors.
5. Access to testing services, capability and equipment.
6. Research and development interests within universities.
7. Sources for relevant documents.

CTN Mission and Goals

Mission - to provide integrated, accessible pathways to information and services relevant to small and medium sized enterprises using technology.

The goals of the CTN are:

- to better link existing providers of industrial support services, existing networks, and sources of information and expertise
- to enhance the capacity of current networks by finding organizations to deliver services and expertise to complement those already available
- to provide better access to international sources of expertise

How CTN Works

The Canadian Technology Network can give access to technology and related business assistance through a cross-country network of organizations and advisors. Each advisor is employed by an organization known for its technology or related business competence. These advisors are linked together to optimize the identification and referral to delivery of the right advice or expertise to meet interactive business needs.

Contact

NATIONAL RESEARCH COUNCIL CANADA
1500 Montreal Road, Ottawa, ON K1A 0R6
Telephone English (613) 745-1576

Alberta Research Council

This Organization maintains a web site at <http://www.arc.ab.ca/>

Mission Statement

In partnership with global leaders, ARC helps to advance the economy and well-being of Alberta by providing technology and innovation to meet current and emerging needs of industry and government.

Divisions

- Advanced Systems Applications
- Agriculture
- Biotechnology
- Energy
- Environment
- Forestry
- Manufacturing

Advanced Industrial Materials and Processes Service/Knowledge

To help industrial clients develop new products and become more competitive globally, the Advanced Industrial Materials group offers services and capabilities to client projects. Expertise is available from the inception to the final stages of product development in the following areas:

- powder metallurgy
- metallurgy
- ceramics
- coatings and surface
- mechanical engineering
- mechanical design and testing
- wear
- chemical process development
- corrosion and electrochemical engineering
- polymer and plastics technology
- numerical and physical modeling of plastic molding processes, e.g., injection molding and blow molding.

Address

Alberta Research Council
250 Karl Clark Road
Edmonton, AB
T6N 1E4

Main telephone number

Phone: (780) 450-5111
Fax: (780) 450-5333

Contacts

John McDougall
Manager Director & CEO
Phone: (780) 450-5200
Fax: (780) 450-1490
E-mail: mcdougall@arc.ab.ca

Clientele

ARC's customers and partners include small to medium-sized enterprises, large companies, universities, government agencies and departments, as well as international organizations.

Date of Incorporation

1921/01/06

Centre Prototech / Prototech Centre

This organization maintains a website at <http://www.prototech.polymtl.ca/>

Profile Summary

A non-profit corporation, the Centre opened in 1998 to help companies in many industrial sectors adapt to fast-changing markets.

Mission

Its mission is to foster adoption of new technologies and methodologies for rapid development of products and processes by manufacturers in Quebec and Canada as a whole.

The network includes a technological showcase. Members gain access to a unique, integrated resource and equipment platform, and enjoy many advantages:

- Sharing with the founding partners, a modern, highly specialized equipment facility on the leading edge of technology.
- Access to highly skilled experts to solve specific problems
- Reduction of costs by participating in interest groups working on common R&D projects
- Benefit from privileged information and the founding partners' high-level expertise

Founding Members

Sponsored by École Polytechnique de Montréal, the Centre counts among its founding members such prestigious partners as the Industrial Materials Institute (IMI) of the National Research Council of Canada (NRC) and the Centre de haute technologie de Jonquière.

Government Partners

The establishment of the Centre was made possible by the financial support of the Ministère de l'Industrie, du Commerce, de la Science et de la Technologie du Québec (Ministry of Industry, Trade, Science and Technology of Quebec), and Economic Development Canada.

Market Categories Served

Steel Mills
Aerospace
Other
Electrical
Packaging
Environmental
Fabrication
Food Processing
Forestry
Forming
Oil, Gas, and Petrochemical
Furniture
Mining
Pulp and Paper
Rubber or Plastic Parts
Automotive

Contact Information

**Centre Prototech / Prototech Centre
C.P. 6079 Succ. Centre-Ville
Montréal, Quebec
H3C 3A7
Phone: (514) 340-3245
Fax: (514) 340-3246
Email: services@prototech.polymtl.ca**

Centre de recherche industrielle du Québec (CRIQ)

This organization maintains a website at www.criq.qc.ca

CRIQ is a leader in Quebec in manufacturing technologies, environment and industrial information. As one of the most important centres of innovation and expertise, it offers highly competitive solutions in numerous industrial sectors.

Since June 1997, CRIQ has been a Crown corporation to which the Minister of Finance (of the province of Quebec) has undertaken to contribute \$24 million over five years.

Automation

CRIQ's Automation Division has won world acclaim for its innovations that are as original as they are practical. CRIQ's objective is to enable companies to obtain the level of productivity they seek, to meet the standards of quality required and to reduce losses in production.

Specialists in machine design, artificial vision, robotics and control are all part of a multidisciplinary team capable of integrating complex technologies into existing factory conditions.

CRIQ focuses on research and development efforts in the manufacturing sector and is accomplished in the areas of:

- Machine design
- Control
- Robotics
- Artificial vision

Contact

CRIQ

8475, avenue Christophe-Colomb

Montréal PQ

Canada

H2M 2N9

Telephone (514) 383-1550

Fax (514) 383-3250

Toll free 1 800 667-4570

E-Mail infocriq@criq.qc.ca

Inforex

Inforex was founded in May of 1996 by the senior specialist in technological information at the Quebec Industrial Research Center (CRIQ) in Montreal.

Inforex provides a highly specialized expertise in scientific, technological, industrial and commercial information research for companies who are in the Advanced Manufacturing sector. Inforex offers information on technical documents, standards, patents, supply source for rare components or parts with non-standard specifications, technology watch and information on R&D from Europe or Asia.

Inforex can also prepare a custom made Technological Information Report (TIR), which is a mini "Technological Status Report" that provides investors with an objective vision of the technological and commercial potential of a project.

Specialties

Automation/Robotics

- Artificial vision system for quality control in manufacturing Laser engraving systems for integrated circuits (IC's) manufacturing
- Robotized deburring systems for aerospace industry
- New technological developments in automation for the chemical industry
- High level robotic languages for space station control

Electronics/Computers

- Electronic noise attenuation systems
- Computerized system for climatic and meteorological data processing
- Micro-wave detection and classification of vehicles
- Inspection of printed circuit boards with x-rays
- Radio-frequency anti-theft systems
- Market for DSP development circuit boards
- Localization with satellites and cellular telephony

Medical/Biotechnology

- Industrial applications and market potential for a new biofungicide
- Medical spectrometry and imaging systems
- North-American and European markets for prosthesis and orthosis
- Tridimensional digitizing systems for limbs and articulations

Market Categories Served

Aerospace
Electrical
Fabrication
Forming
Oil, Gas, and Petrochemical

Major customers

Development Bank of Canada
General Electric of Canada Inc. (Aircraft engines)
Hydro-Quebec
Natural Resources Canada
Centre de Recherche Industrielle du Québec, CRIQ
DMR Group

Contact Information

Inforex
3618 Jonathan Street
Laval, Quebec
H7P 4Y8
Phone: (450) 963-4598
Fax: (450) 963-5194
Email :inforex@videotron.ca

InNOVAcorp

This Organization maintains a web site at <http://www.innovacorp.ns.ca>

Mission Statement

InNOVAcorp is a one-of-a-kind organization supporting individual companies through technology commercialization and growing industry sectors through partnerships. Over 100 business, engineering and technical staff are experienced in providing an array of commercialization and partnership services. InNOVAcorp adds value to our commercialization services through our many partnerships. InNOVAcorp is committed to building three promising knowledge-based sectors in Nova Scotia: life sciences, information technology, and advanced materials and engineering.

Divisions

- Commercialization Services
- Sector Development
- Testing Services

Address

InNOVAcorp
101 Research Drive
P.O. Box 790
Dartmouth, NS
B2Y 3Z7

Contact

Suzann Sykes
CTN Commercialization Advisor
Phone: (902) 424-8670 ext. 178
Fax: (902) 424-4679
E-mail: ssykes@innovacorp.ns.ca

Materials and Manufacturing Ontario (MMO)

This Organization maintains a web site at <http://www.mmo.on.ca>

Mission Statement

Materials and Manufacturing Ontario (MMO) is a Centre of Excellence committed to making connections between the best university research and the needs of Ontario industry. Since 1987, MMO has supported research in materials and manufacturing, developed partnerships, trained graduate students with an industrial orientation and transferred knowledge and technology to industry.

MMO is a not-for-profit corporation supported by the provincial government, industrial contributions to research programs, and revenues from the commercialization and licensing of intellectual property. MMO's overriding objective is to maximize its impact on sustained economic growth and well being in the Province of Ontario. Everything at MMO, including our strategies, philosophy, values, programs and behaviour is designed to maximize our economic impact.

Divisions

**Education and Training Programs
Industry/University Programs
Licensing and Commercialization
Research Programs**

Address

**Materials and Manufacturing Ontario (MMO)
The Promontory II Sheridan Science and Technology Park
2655 North Sheridan Way, Suite 250
Mississauga, ON
L5K 2P8**

Contacts

**Ms. Colleen Mulholland
Director, Communications and Administration
Phone: (905) 823-2020 ext. 230
Fax: (905) 823-4141
E-mail: colleen@mmo.on.ca**

**Dr. Grant Allan
President
Phone: (905) 823-2020
Fax: (905) 823-4141
E-mail: gallan@mmo.on.ca**

Aerospace Industries Association of Canada

The Aerospace Industries Association of Canada (AIAC) is the national trade organization of Canada's aerospace manufacturing and service sector. AIAC is the voice of Canada's aerospace community. The AIAC maintains a website at www.aiac.ca

Mission

The goal of AIAC is to enhance the competitiveness of the Canadian aerospace industry through cooperative efforts among AIAC member companies, and direct contact with governments.

AIAC represents the interests of 200 large and small Canadian enterprises that generate more than 60,000 high technology jobs, with sales of more than \$13.5 billion in 1997.

The industry is a modern and strategic high technology sector of Canada's economy. Canada's aerospace sector has a strong focus on commuter aircraft, and a dominant world product mandate for commercial helicopters. The industry also leads the world in the production of gas turbine engines, full flight simulators, avionics, electronics, space systems, communications, and repair & overhaul services.

The Work of the Association

As the voice of Canada's aerospace industry, the Association undertakes advocacy work on behalf of the member companies. Advocacy involves working with officials and elected representatives of government and agencies to address issues, or to present an industry position during policy development discussions. The issues may range from procurement practices, to regulatory barriers to trade and partnering with government.

The other principal activity of the Association is promoting export opportunities for the industry. Export promotion activities are directed at supporting member company efforts to maintain and expand market share in traditional markets and exploit new opportunities in emerging markets.

Mandate statements of AIAC Councils

In addition to various Committees, the Association has established five councils:

The Technology Council

To provide strategic guidance on the complete spectrum of science and technology issues as they impact the growth, development and competitiveness of the industry. Facilitating aerospace product and process innovation at all levels in the Canadian aerospace industry, at universities, and at other research establishments.

The Trade Council

To provide strategic issue guidance for AIAC's advocacy efforts in the areas of trade policy, market access and international business development. Increasing Canada's share of world aerospace markets is a key objective of the Council.

The Trade Council is also the AIAC focal point for strategic initiatives aimed at supporting industry's efforts to compete and cooperate in the global aerospace market and to penetrate new offshore markets.

The Human Resources Council

To provide strategic guidance on the full spectrum of human resources issues as they impact the industry's ability to attract, develop and maintain the highly skilled, adaptable and productive workforce essential to sustaining and growing Canada's world class aerospace capabilities.

The Defence Procurement Council

To provide strategic issue guidance to the AIAC Board of Directors and member companies on government procurement policies and initiatives as they impact the growth and international competitiveness of the industry. Ultimately, the Council assists the government in obtaining the best value from its procurement expenditures whilst maximizing industrial development.

The Suppliers Council

To provide an independent, collective voice on behalf of Canadian aerospace SMEs through the AIAC Board of Directors and Executive Committee, to Governments, to domestic and international markets, and to the Canadian public.

To provide Canadian aerospace SMEs with a forum for mutual support and self-help through better communications, teaming and mentoring.

Contact

Aerospace Industries Association of Canada
Suite 1200, 60 Queen Street
Ottawa, Ontario K1P 5Y7

Telephone: (613) 232-4297

Facsimile: (613) 232-1142

E-Mail: info@aiac.ca

The Canadian Aeronautics and Space Institute

This organization maintains a website at www.casi.ca The Canadian Aeronautics and Space Institute (CASI) is a non-profit scientific and technical organization for aerospace professionals.

CASI services and opportunities include, a nationwide network of professional contacts, leading edge technical information and a forum in which to present and discuss new concepts and applications

CASI'S Role

CASI was created to advance the art, science, engineering and application of aeronautics and space in Canada. Today, the Institute is a focal point for communications among members of the aeronautics and space community.

CASI is also a strong voice for research and development, and supports science and engineering education in Canada. CASI operates six technical sections that focus on aeronautics, astronautics and associated technologies and is associated with three constituent societies: the Canadian Navigation Society; the Canadian Remote Sensing Society, and the Canadian Air Cushion Technology Society.

Activities

CASI's conferences and symposia bring together scientists, engineers, astronauts, technologists, flight personnel, educators and corporate sponsors. Annual conferences on aeronautics, astronautics and remote sensing draw national and international attention. As a member of the International Council of Aeronautical Sciences and the International Astronautical Federation, CASI participates in their meetings and hosts those held in Canada.

CASI Publications

CASI publishes The Canadian Aeronautics and Space Journal (concentrates on aeronautics and astronautics) and the Canadian Journal of Remote Sensing.

Public Policy

Whether encouraging greater emphasis on education, commenting on the government's long-term space program, or providing expert panels to consider aerospace issues, CASI is an active participant in public policy. The Institute takes special interest in issues involving research and development, as well as science and engineering education in Canada.

Contact

**130 Slater Street, Suite 818
Ottawa, Ontario, Canada K1P 6E2
Telephone - 613-234-0191
Fax - 613-234-9039
Electronic mail casi@casi.ca**

Canadian Space Agency

This organization maintains a website at www.space.gc.ca

CSA History

On December 14, 1989, the Canadian Space Agency (CSA) was officially established by an act of Parliament, with the mandate to promote the peaceful use and development of space for the social and economic benefit of Canadians.

Canada's experience in space began in 1962, with the launch of the Alouette 1 research satellite. Canada was the first country in the world after Russia and the

United States to design and build its own satellite. With the launching of Anik A1 in 1972, Canada became the first country in the world to have its own commercial geostationary communications satellite network. In 1976, a Canada-U.S. cooperative effort led to the launch of the Hermes communications satellite, which subsequently served as a prototype for direct broadcast satellites.

In 1981, Canada confirmed its position as a world leader in space technology with the development of the Remote Manipulator System, or Canadarm. The RMS can be used: to deploy and retrieve satellites, to hold targets, to explore samples, and to manipulate hardware for the Space Shuttle. The Canadarm was used for the first time aboard the Space Shuttle Columbia in 1981. More recently Canada provided the Wind Imaging Interferometer (WINDII), as part of NASA's Upper Atmosphere Research Satellite (UARS) program, used to measure wind velocity and atmospheric temperatures, and to aid in monitoring of the stratospheric ozone. In late 1995, RADARSAT-I was launched. RADARSAT-I is now the premier civilian Earth observation radar satellite in the world.

About the CSA

The Canadian Space Agency (CSA) brings together the larger part of the existing space activities of the federal government. To accomplish its mission, the Canadian Space Agency coordinates all elements of Canada's Space Program and manages five major sectors:

1. Space Systems

Includes Canada's contribution to the International Space Station

2. Space Operations

Consisting of the David Florida Laboratory, a spacecraft testing facility, and RADARSAT, Canada's first Earth observation satellite launched November, 1995

3. Canadian Astronaut Office

4. Space Science

5. Space Technologies

Canada's international partnership with the European Space Agency (ESA).

Mission

The Canadian Space Agency is committed to leading the development and application of space knowledge for the benefit of Canadians and humanity. To achieve this, the CSA will pursue excellence collectively, advocate a client-oriented attitude, support employee-oriented practices and open

communications, commit itself to both empowerment and accountability and pledge to cooperate and work with partners to our mutual benefit.

Contact

**Canadian Space Agency
6767 Route de l'Aéroport
Saint-Hubert, Québec
Canada J3Y 8Y9**

Telephone: 1-450-926-4800

Fax: 1-450-926-4352

Center for Technologies in Aerospace (CTA)

Mission Statement

The mission of the Center for Technologies in Aerospace (CTA) is to provide small business and government agencies with the tools required to develop aerospace industry products, and to provide services relating to aeronautics, airport technologies, aviation, space, applied information technologies and technology transfer.

Service/Knowledge Offerings

FCAR Funds

Research and Development

Specialized Training

Technological Firm Incubator

Technology Transfer

Miscellaneous Information

The Center for Technologies in Aerospace (CTA) is a non-profit organization supporting the development and growth of the Quebec aerospace industry. CTA is strategically located within the St-Hubert airport industrial park, in the greater Montréal metropolitan area. This area is also home to a number of internationally renowned organizations such as the Canadian Space Agency, the ICAO, IATA and SITA. In addition, the CTA is allied with the École nationale d'aérotechnique (National Aerotechnical School), which provides the Centre with access to more than \$40 million worth of high-tech installations and over 150 aeronautics specialists for its R&D projects.

Address

Center for Technologies in Aerospace (CTA)

5555, place De La Savane

St-Hubert , QC

J3Y 5K2

Contacts

Lucie Cousineau, Director

Phone: (450) 678-2001

Fax: (450) 678-1702

e-mail: lcousineau@collegeem.qc.ca

François Demers, Project Officer

Phone: (450) 678-2001

Fax: (450) 678-1702

e-mail: fdemers@collegeem.qc.ca

Centre for Research in Earth and Space Technology (CRESTech)
This Organization maintains a web site at <http://www.crestech.ca>

Mission Statement

CRESTech was founded in 1997 and has offices in Toronto and Waterloo in Ontario. Our mission is:

- to achieve and maintain world-class excellence in multidisciplinary collaborative research and development in space and earth sciences with a focus on: water, earth and the atmosphere
- to transfer and diffuse the results of that research and development to industry and the public sector to ensure future global competitiveness and economic growth for Ontario and Canada
- to advance the management of our natural resource capital by providing leadership and innovative solutions in measuring, monitoring and remediating earth's environment
- to contribute to the education and training of highly qualified scientists, engineers and technologists, and entrepreneurs
- to develop the scientific, socioeconomic, industrial and financial basis for the assured continuance of CRESTech beyond the current five-year framework.

Divisions

Atmospheric Studies Research
Land Resources Research
Water Resources Research

Service/Knowledge Offerings

Controlled Environment Systems
CRESTech Business Development Fund
CRESTech Graduate Student Conference Travel Awards
CRESTech Industrial Cooperative Research Awards
CRESTech Membership Advantages
Human Performance in an Aerospace Environment
Seeking Proposals for Research Projects
Space Science and Technology Research

Addresses

Centre for Research in Earth and Space Technology (CRESTech)
4850 Keele Street
North York , ON
M3J 3K1

Main telephone number

Phone: (416) 665-3311
Fax: (416) 665-2032

Contacts

Dan McGillivray
Bus. Development & Tech Transfer: Earth Systems
Phone: (519) 888-4875
Fax: (519) 888-4330
e-mail: mcgill@admin.crestech.ca

Leanne Gelsthorpe

Manager, Business Liaison
Phone: (519) 888-4423
Fax: (519) 888-4330
e-mail: lgelstho@admin.crestech.ca

Appendix 3 – Trade Associations

Alliance of Manufacturers and Exporters Canada

This Organization maintains a web site at <http://www.palantir.ca/the-alliance/>

Mission Statement

The mission of Alliance of Manufacturers & Exporters Canada is to continuously improve the competitiveness of Canadian industry and to expand export business.

The Alliance is an association of companies as well as research and technology organizations, all with the focus of adding “...value to our enterprises through the sharing of expertise and resources, and to address technology opportunities and challenges.” The Alliance produces reports on the economic outlook of Canadian industry and exporting, as well as offering courses, seminars and educational linkages. The Alliance of Manufacturers and Exporters Canada is the flagship; however there are provincial organizations that mirror the national body.

Service/Knowledge Offerings

- Advanced Technology Resources
- Business Impact Test
- Information, Programs and Support Services
- Professional Growth
- Promotion of Canadian Businesses
- Training and Learning Opportunities

Address

Alliance of Manufacturers and Exporters Canada
Suite 904
1080 Beaver Hall Hill
Montreal, PQ
H2Z 1S8

Main telephone number

Phone: (514) 866-7774

Fax: (514) 866-3779

Contact

Rémi Boudreault

Director, Business Development

Phone: (514) 866-7774 ext. 103

Fax: (514) 866-3779

e-mail: remi_boudreault@l-alliance.com

Clientele

The Alliance welcomes among its members: manufacturers, exporters of goods and services, research organizations and the service companies and others who support them.

Date of Incorporation

1972

Automotive Parts Manufacturers' Association

This Organization maintains a web site at <http://www.capma.com>

Mission Statement

The Automotive Parts Manufacturers' Association (APMA) is Canada's national association representing OEM producers of parts, equipment, tools, supplies and services for the worldwide automotive industry. APMA's fundamental objective is to promote the Canadian automotive parts manufacturing industry both domestically and internationally. APMA is the voice of the automotive parts industry.

Service/Knowledge Offerings

- APMA Annual Conference and Exhibition
- Automotive Industry Outlook Conference
- Canadian Directory of Automotive Parts Manufacturers
- Environmental Assistance
- Environmental Workshops
- Human Resources Issues Conference
- Lobbying

Address

Automotive Parts Manufacturers' Association
195 The West Mall, Suite 516
Toronto, ON
M9C 5K1

Main telephone number

Phone: (416) 620-4220
Fax: (416) 620-9730

Contact

Paul Brown
Director, Marketing
Phone: (416) 620-4220
Fax: (416) 620-9730
e-mail: pbrown@interware.net

Clientele

APMA members represent approximately 90% of the 26 billion automotive parts manufacturing industry in Canada.

Date of Incorporation

1952

Canadian Advanced Technology Association

This Organization maintains a web site at <http://www.cata.ca>

Mission Statement

CATA Alliance is a results driven national trade association, comprised of over 1000 "new economy" enterprises. The common purpose that unites the membership is CATA Alliance's commitment to members' business growth. With offices across the country, CATA Alliance is focused on the provision of business services that conserve and leverage member resources. Because members are action-oriented businesses, CATA Alliance responds with action when members need specific services.

The "Traditional Champion" of Canadian research and development, CATA Alliance's mission is to stimulate "Global Business Growth" through the forces of Canadian innovation and strategic partnership.

Service/Knowledge Offerings

- CATA Annual Conference
- On-going seminar and conference series
- Skills tracking
- Software showcase
- "TechnoGate" (listing of members skills and specializations for networking / partnership purposes)
- CATA Alliance actively participates in the monitoring and formation of government policies and programs that can benefit or change the business environment. CATA Alliance's advocacy agenda is driven by members' needs.

Address

CATA Alliance National Headquarters
388 Albert Street
Ottawa, ON
K1R 5B2

Main telephone number

Phone: Tel: (613) 236-6550
Fax: (613) 236-8189

Contact

None listed
inquiry@cata.ca

Clientele

Over 9000 executives from home/small business, small to medium enterprises, and multinational enterprises in electronics, telecommunications, etc as well as members from support industries, including finance, accounting, consulting and legal companies.

Canadian Association of Mining Equipment and Services for Export

This Organization maintains a web site at <http://www.camese.org>

Mission Statement

The Canadian Association of Mining Equipment and Services for Export (CAMESE) is the national voice for Canada's mining equipment and service exporters.

The association's corporate members across the country supply most of the products and services required for successful mining.

Service/Knowledge Offerings

Services for buyers

If you are a mining industry end-user, broker, agent, or distributor, CAMESE invites you to use the web-site to discover the broad range of goods and services offered to the mining industry by member companies.

Services for members

- International Mining Events
- 1998 Compendio de CAMESE de Abastecedores Canadienses para la Minería - En Español
- Exposure in the annual Compendium of Canadian Mining Suppliers, printed in 20,000 copies and distributed world-wide
- exposure in the bi-annual Spanish-language Compendio de CAMESE de Abastecedores Canadienses para la Minería, printed in 20,000 copies and distributed throughout Latin America.
- information about export sales opportunities, market conditions, trade shows, trade missions and other events
- public relations, direct mail, Internet and other marketing tools for successful selling to the international mining sector,
- advocacy of the mining supply sector to the mining industry, the Canadian public and governments

Address

CAMESE
Suite 101, 345 Renfrew Drive
Markham, ON
L3R 9S9

Main telephone number

Phone: Tel: (905) 513-0046
Fax: (905) 513-1834
MINESUPPLY@CAMESE.ORG

Clientele

CAMESE has 200 members active in mineral exploration, mine development, mining engineering and services, mineral processing, environmental monitoring and other specialties.

Date of Incorporation

1981

Canadian Association of Moldmakers (CAMM)

This Organization maintains a web site at <http://www.cdnmolds.com>

Mission Statement

The Canadian Association of Moldmakers (CAMM) Inc. is resolute in the betterment of the mold industry in Canada and dedicated to industry excellence. In addition, it is CAMM's mission to educate youth about the potential in entering the mold making trade through apprenticeships, to represent its members in a unified voice to the governments at all levels (lobbying, education, advisory participation) and to represent its mold maker members at trade shows abroad and in Canada in order to widen the customer base of its members. We also work on establishing a national standard for mold making training and certification and are actively involved in improving the apprenticeship system.

Service/Knowledge Offerings

- CAMM Directory
- CAMM News
- Trade Conference
- Windsor Mold Show

Miscellaneous Information

The Canadian Association of Moldmakers (CAMM) is an organization consisting of moldmakers, suppliers and service member companies. It was formed for the sole and exclusive purpose of fostering the interests and addressing the concerns of Canadian moldmakers. We are able at this time to communicate and therefore serve our customers and contacts in English, French, German, and Spanish. We are Canada-wide, though still growing.

Address

Canadian Association of Moldmakers (CAMM)
424 Tecumseh Road East
Windsor, ON
N8X 2R6

Main telephone number

Phone: (800) 567-2266
Fax: (519) 225-9446

Contact

Patricia Papp
Executive Secretary
Phone: (519) 255-7863
Fax: (519) 255-9446
e-mail: cdnmolds@mnsi.net

Clientele

Our members have clientele in all parts of the world. The CAMM Moldmakers are known for their quality work world-wide. Our members constantly engage in technology transfer and research and development in order to afford the best services and products to their customers. Our customer circles encompass automotive, medical, toy, household, furniture and recreational areas, serving them with prototypes, blow molds, stack molds, injection molds, RIM, thermoset, and practically any plastic forming application and fixture.

Date of Incorporation
Unknown

Canadian Plastics Industry Association

This Organization maintains a web site at <http://www.plastics.ca>

Mission Statement

The mission of the Canadian Plastics Industry Association (CPIA) is to advance the prosperity and international competitiveness of the Canadian plastics industry in an environmentally and socially responsible manner.

Service/Knowledge Offerings

"Down to Earth - Highlights"

13th Biennial Salary Survey - Plastics Processing, 1996

1997 Canadian Plastics Machinery and Molds Directory

1998 Atlantic Plastics Industry Directory & Export Capabilities Guide

A Review of the Role of Plastics in Energy Recovery

A Sustainable Approach to Plastics Recovery in Nova Scotia

Advanced Technologies for Integral Parts

Annual Financial and Operating Ratios Survey

Annual International Status Report on Plastics (IPAD)

Annual Labour Survey - Plastics Processors

Blends and Alloys

C.P.I.A. 1998/1999 Reference Guide and Sourcebook

Canadian Plastics Statistical Yearbooks

Comparison of Technologies

Councils

EMI Shielding

Environment and Plastics Council Newsletter - News & Views

EPIC - Publication - Backgrounders - Fact Sheets

EPIC Publication - Answers to Your Questions...

EPIC Publication - How to Implement a Plastics Recycling Program

EPIC Publication - Making the Most of Our Resources

EPIC Publication - Plastics Sortation Optimization Guide

EPIC Publication - Source Reduction: The Invisible R

EPIC Publication - Stretch Wrap Recycling: A How-To Guide

Fact Sheets from the Vinyl Council of Canada

Guide to Resource Conservation and Cost Savings Opportunities

Handling Plastics in a Materials Recovery Facility (MRF)

High Performance Engineering Thermoplastics

Library - Technical Information Resource Centre

New Brunswick's Plastics Industry: Competing in the Global Marketplace

Nova Scotia's Plastics Industry: Profile, Issues and Challenges

On-Line Data Searches

Plastics Identification Kit

Plastics Opportunities for Metal Formers

Project Consulting

Public Seminar - Grow Your Business with Innovative Financing - Nov 25

Publication - 1995 R&D Compendium

Publication - Evolution of Milk Packaging & the Effect on Solid Waste

Publication - International Symposium Proceedings

Publication - Material Recovery Facility (MRF), Processing Cost Model

Publication - Municipal Recycling Collection Cost Model - Version 2.0

Publication - Plastics Primer

Publication - Report on Dioxins - Status of U.S. and Europe

Publication - Review of Blow Moulding

Publication - Review of Composite Processes

Publication - Review of Extrusion
Publication - Review of Injection Moulding
Publication - Review of Thermoforming
Publication - The Additives Primer
Reactive Processing of Polymers, Volume II
Resource Conservation Guide for Plastics Processing
Second Annual CPIA Canada Mould Makers Labour Survey, 1997
Technical Aspects of Quality
Technical Information Bulletins (T.I.B.)
Test Services
In-House Custom Seminar - Injection Moulding
Laboratory Testing

Addresses

Canadian Plastics Industry Association
5925 Airport Road, Unit 500
Mississauga , ON
L4V 1W1

Main telephone number

Phone: (905) 678-7748
Fax: (905) 678-0774

Contacts

Sally Press
Consultant, Information Services
Phone: (905) 678-7405 ext. 228
Fax: (905) 678-0774
e-mail: spress@cpia.ca

Clientele

Raw material suppliers, machinery and equipment suppliers, mould makers, processors, OEMs

Date of Incorporation

01/01/97

Canadian Tooling & Machining Association

This Organization maintains a web site at <http://www.ctma.com>

Mission Statement

The CTMA represents and promotes the interests of the Canadian tooling and machining industry. The CTMA mandate is to be an effective, broad-based, respected organization, representing the Canadian tooling and machining industry, nationally and internationally.

Service/Knowledge Offerings

- Annual Apprenticeship Competition
- Annual Wage and Fringe Benefit Survey
- International Connections
- Services to CTMA Members

Address

Canadian Tooling & Machining Association
140 McGovern Drive, Unit #3
Cambridge, ON
N3H 4R7

Main telephone number

Phone: (519) 653-7265

Fax: (519) 653-6764

Contacts

Mr. Russell Gorham

General Manager

Phone: (519) 653-7265

Fax: (519) 653-6764

e-mail: info@ctma.com

Clientele

Our target clientele includes manufacturers involved in producing tooling and machining products.

Date of Incorporation

1979/01/16

Electro-Federation Canada

This Organization maintains a web site at <http://www.electro.ca>

Mission Statement

EFC stages a dialogue on issues affecting electro-technical businesses. The Federation's unique Council structure provides flexibility for members from different segments of industry to deal with issues that are specific to this sector.

Service/Knowledge Offerings

- Sharing of cost-effective unparalleled statistical market and business information
- Members only reports and forecasts
- Workshops and committees
- Alliances with other organizations
- Lobbying

Address

10 Carlson Court
Suite 210
Toronto, Ontario
M9W 6L2

Main telephone number

Phone (416) 674-7410
Fax: (416) 674-7412

Contacts

NA

Clientele

200 Canadian manufacturers and wholesale distributors associated with electrical, electronic and telecommunications products.

Date of Incorporation

NA

Industrial Research+Development Institute (IRDI)

This Organization maintains a web site at <http://www.irdi.on.ca>

Mission Statement

The Industrial Research+Development Institute (IRDI) will be the leading self-supporting supplier of research and technical information to the tool, die and mould and net shape manufacturing industries, its customers and suppliers as well as educational institutions and government. IRDI's mission is to accelerate the development and introduction of advanced technologies to industry.

Service/Knowledge Offerings

- APEX: Plastics Design and Manufacturing Workshop Series
- IRDI Seminars and Workshops
- Knowledge Centre
- Machining Technology Group
- Metalforming Technology Group
- Plastics and Composites Technology Group
- Research and Development Services

Miscellaneous Information

The Industrial Research+Development Institute, located in Midland, Ontario, is a member driven research and development institute founded in 1992 to provide advanced technical and research support to companies involved in the shaping of materials. This includes the Tool, Die, Mould and the net shape manufacturing related industries in Canada.

Address

Industrial Research+Development Institute (IRDI)
649 Prospect Blvd.
PO Box 518
Midland, ON
L4R 4L3

Main telephone number

Phone: (705) 526-2163
Fax: (705) 526-2701

Contacts

Colin Harper
President and CEO
Phone: (705) 526-2163
Fax: (705) 526-2701
e-mail: charper@irdi.on.ca

Clientele

Manufacturers, producers; tool, die, mould makers; materials and equipment suppliers; individual consultants; professional associations.

Machinery & Equipment Manufacturers' Association of Canada

This Organization maintains a web site at <http://www.memac.org>

Mission Statement

MEMAC's mission is to promote the development and growth of a strong, internationally competitive machinery and equipment industry in Canada.

Objectives include: MARKET DEVELOPMENT (To pursue domestic and export market enhancement); ADVOCACY (To provide an effective voice to government and other groups important to the continued well-being of the industry); NETWORKING (To provide a forum for the exchange of business information and opportunities); WATCHDOG (To provide members with a channel for early warning and consultation on government intentions which could affect them);

PROBLEM SOLVING (To undertake remedial action for problems affecting the industry at large or any of its particular sub-sectors); INFORMATION GATHERING (To maintain an industry information and statistical bureau that is of benefit and value to the members); TECHNICAL SUPPORT (To provide the medium to monitor or to effect changes in standards, production technology, specifications, etc); PUBLIC RELATIONS (To make the public aware of the industry and the important role it plays in the Canadian economy.)

Service/Knowledge Offerings

- The opportunity to meet quarterly with industry colleagues to learn about business prospects, exchange information, discuss problems and make contacts.
- The acquisition of information on a variety of important issues from the expert analysts that speak regularly at MEMAC meetings and seminars.
- Inclusion in the MEMAC Information Manual, a catalogue of members' products to government departments, particularly for trade offices and trade shows
- Participation in the formulation of the industry's position on key policy issues.
- Participation in government sponsored missions and trade shows and on government task forces and advisory groups.

Address

MEMAC
116 Albert Street, Suite 701
Ottawa, Ontario
K1P 5G3

Main telephone number

Telephone: (613) 232-7213
Fax: (613) 232-7381

Contacts

NA

Clientele

MEMAC represents companies that manufacture machinery, equipment, components, peripherals and process systems. Member firms manufacture machinery for pulp and paper plants, for sawmills and for forest harvesting. They supply equipment for mining and mineral processing, for hydroelectric plants and utilities, and for the automotive and steel industries. MEMAC members make environmental equipment for waste treatment, water purification and sewage systems. They make equipment such as valves, pumps, gears and pressure vessels for the oil and gas, construction and other industries. Manufacturers of material handling equipment, including cranes and conveyors, are represented by MEMAC, so too are firms making packaging equipment and printing machinery.

MEMAC's membership currently stands at around 100 companies. These firms account for a significant portion of an industry that has over \$14.7 billion in annual sales and employs approximately 89,000 people.

Appendix 4 – University Activities

Manufacturing

École Polytechnique de Montréal

Applied Polymer Research Centre (CRASP)

This institution maintains a website at www.polymtl.ca

Research Programs

The Centre main activities are:

- a) composites manufacturing and testing
- b) modeling, computer-assisted design (CAD) and development of polymer and composite manufacturing processes

- c) materials development
- d) mechanical and thermomechanical characterization
- e) rheological behaviour during processing
- f) damage and fracture of composite materials
- g) properties of injection-molded reinforced thermoplastics
- h) plastic recycling
- i) gear performance and wear of plastics

Recent achievements include:

- a) development of RTMFLOT software for ports and mold design for resin transfer molding, SRIM and the Infusion processes
- b) development, in cooperation with industry, of user-friendly simulation software for extrusion processes
- c) development of "coextruded" multicoat films with barrier properties
- d) development of very high density materials that can be molded by injection
- e) development of an on-line capillary rheometer coupled to an injection-molding machine, allowing the rheological characterization at high shear rates of long fiber-reinforced thermoplastics
- f) development of high-performance pultruded composites

Specialized Equipment(s)

Injection molding machine; single and twin-screw extruders; various apparatus for rheological, thermomechanical and chemical characterization of polymers and composites.

External Source(s) of Funding:

NSERC, FCAR, Aérospatiale, Camoplast, ELF Atochem, IBM, IRSST, Northern Telecom, Shell, 3M, Matra, SNECMA, Ford, ACM Composites, Beauce Composites, Pultrusion Technique.

Address:

École Polytechnique de Montréal
P.O.Box 6079, Downtown Station
MONTREAL, PQ
Canada, H3C 3A7

Contact:

Director: Pierre Carreau
Co-director:: Raymond Gauvin
Tel.:(514) 340-4711 #4629
Fax:(514) 340-2994
E-mail: pcarreau@mail.polymtl.ca

McMaster University

Intelligent Machines and Manufacturing Research Centre
The website for this division is <http://immrc.eng.mcmaster.ca/immrc.htm>

The Intelligent Machines and Manufacturing Research Centre, (IMMRC) is involved in fundamental and applied research projects in cooperation with industrial partners and government agencies in fields of strategic importance to the manufacturing industry. The research being undertaken involves integrated development in areas of metal working,

process modeling, CAD/CAM, sensors, high speed special purpose computing and signal processing, artificial intelligence and controls. IMMRC is interdisciplinary with the participation of faculty members from the Mechanical Engineering, Electrical and Computer Engineering, and Materials Science and Engineering Departments at McMaster University. The Intelligent Machines and Manufacturing Research Centre, created in 1992, provides a focus for high profile research and is a vehicle for University – industry - government interaction in the field of intelligent machines and manufacturing. IMMRC provides systematic mechanisms for technology transfer and diffusion of knowledge and research results. These mechanisms include contractual research and development projects, research reports, short courses, workshops/seminars and training facility for industry employees to upgrade their knowledge (industrial sabbaticals).

Service/Knowledge Offerings

1. Equipment and Testing Facilities

The IMMRC laboratories offer customized testing and problem solving facilities in metal forming and machining technologies, application of robotic systems to manufacturing tasks, hardware and software aspects of applications of image analysis to manufacturing problems. Through cooperation with the Department of Materials Science and Engineering, access to a wide range of metallurgical tests is also available.

Contact Dr. M.A. Elbestawi, Director, Intelligent Machines & Manufacturing

e-mail: immrc@mcmaster.ca

2. Machine Vision and Image Analysis Laboratory

The Machine Vision and Image Analysis Laboratory features: - two SUN SPARCSTATIONS; - S-bus 24-bit colour image digitizer; - XYZ positioning table; - various monochrome image digitizers, optics and lighting supplies; - 24-bit colour HP document scanner; - 5-axis CRS Robotics A255 articulated robot; and - various image processing software packages.

Contact Dr. D. Capson

Phone: (905) 525-9140

Fax: (905) 572-7944

3. Machining Systems Laboratory

Current research work at the MSL is focussed on the area of Machining Systems, including studies related to advanced machine tools and metal cutting. In general all research projects are rather fundamental in nature; however they are strongly linked to industrial R&D of interest to manufacturing industries involved in machining.

Contact Dr. M.A. Elbestawi, Director, Intelligent Machines & Manufacturing

e-mail: immrc@mcmaster.ca

4. Metal Forming Laboratory

Metal Forming Laboratory features:

- 200 ton servo-hydraulic press
- 50,000 lb M.T.S. servo-hydraulic testing machine
- 10,000 lb Instron testing machine
- custom built M.T.S. cupping press
- Hille cupping press
- five micro-computers
- in-plane torsion tests
- limiting dome height tests
- drop weight tests

- punch stretch tests and stretch-bend tests
- pure bending of strip material
- strip friction tests and sliding friction tests
- strip and rod drawing tests
- forging and blow moulding of superplastic alloys
- determination of forming limit curves for sheet and thin plate material
- sub-presses and platens for small scale upsetting tests on bulk material
- fully automated hydraulic bulge testing facility with circular and elliptical bulging dies
- computer vision system for strain analysis

Contact Dr. M.A. Elbestawi, Director, Intelligent Machines & Manufacturing

e-mail: immrc@mcmaster.ca

5. Robotics and Manufacturing Automation Laboratory

The Robotics and Manufacturing Automation Laboratory is an extensively equipped facility for manufacturing automation research. The laboratory features: - three Industrial Robots (PUMA 762 with 20 kg payload capacity, GMF-A1 with 20 kg payload capacity, and a PUMA-560 with 5 kg payload capacity); - an Open Architecture Cell Controller (based on Delta Tau Motion Controllers); - two PLCs (OMRON and Allen Bradley); - a 6-axis Force Sensor; - a Computer Vision System; - a variety of End of Arm Tooling (including several grippers, deburring tools and polishing tools); and - UNIX and NT-based workstations.

Contact Dr. Gary M. Bone

e-mail: gary@immrc.mcmaster.ca

McGill University

Centre for Intelligent Machines

The Centre maintains a webpage at www.cim.mcgill.ca

CIM Mission Statement

The mission of CIM is to excel in the field of intelligent machines, stressing basic research, technology development, and education. CIM seeks to advance the state of knowledge in such domains as robotics, automation, artificial intelligence, computer vision, systems and control theory, and speech recognition.

More often this is being achieved by collaborative efforts involving researchers with very different interests. Therefore we see that the original objective of forming the Centre to encourage interdisciplinary activities which transcend the traditional departmental boundaries is being attained.

History

Over 25 years ago, a group of researchers in Electrical Engineering began work in Computer Vision. This resulted in a successful NSERC Major Equipment Grant in 1978, which led to the acquisition of a VAX 11/780.

In 1981, two of these researchers, Martin Levine and Steve Zucker, along with two Systems Theory specialists, Pierre Belanger and George Zames, were selected by the Canadian Institute for Advanced Research (CIAR) to constitute one of the three nodes of its program in Artificial Intelligence and Robotics.

CIM or McRCIM (McGill Research Centre for Intelligent Machines as it was then called) was formed in 1985 when these four researchers from Electrical Engineering decided to unite with a common theme - the study of intelligent systems. In order to achieve their goal of interdisciplinary collaboration, they invited researchers from Mechanical, Biomedical and Mining & Metallurgical Engineering and from the School of Computer Sciences to join them.

A grant from the Quebec Ministère de l'Enseignement Supérieur et de la Science (MESS) was critical to the Centre's inception and early growth. This in turn resulted in the University's budget providing CIM with four new faculty positions in 1990. Since 1989, infrastructure funding has been provided by Fonds pour la Formation de Chercheurs et l'Aide à la Recherche (FCAR).

Since the creation of the federal government's Network of Centres of Excellence (NCE) in 1989, of which the Institute for Robotics and Intelligent Systems (IRIS) is one, CIM researchers have benefitted from approximately 25% of the available funds.

Presently CIM occupies the fourth floor of the McConnell Engineering Building, housing 38 offices and 8 laboratories. It is home to 15 professors from three departments, seven research engineers, five technical and administrative support staff and approximately 70 graduate students, of which about a third come from outside Canada.

Consulting Services at CIM

The Centre for Intelligent Machines (CIM), a leader in the information technology sector, offers consulting services to a broad spectrum of clients that include the research community, government and business.

Ranked among the top ten centres in the world specializing in the study of intelligent systems -- robotics, vision, and systems and control -- CIM's central location within the Faculty of Engineering at McGill University allows it to draw upon abundant resources.

An outstanding team comprised of 14 highly accomplished academics, several professional research engineers, over 75 enthusiastic and bright graduate students working in eight state-of-the-art laboratories has contributed to the Centre's status as a world leader in the following areas of expertise:

- Human-Computer Interactions - reactive rooms, shared reality environment
- Artificial Perception Research - active vision, early vision, localization, autonomous exploration, visual interface, content-based image retrieval
- Intelligent Robot Research - mechanical systems, robot locomotion, Haptic Interfaces, space systems
- Systems and control theory

CIM can offer virtually unlimited opportunities to its clients. Its impressive knowledge pool works across many disciplines, perpetuating an environment of synergy, teamwork and considerable business savvy. These talented individuals have the resources, experience and training to solve problems in even the most complex of technologies.

Contact

McGill Center For Intelligent Machines
McGill University
3480 University Street Room 410
Montréal, Québec
Canada

H3A 2A7
Telephone (514) 398-6319
Fax (514) 398-7348
Email cim@cim.mcgill.ca

University of British Columbia

Industrial Automation Laboratory
<http://www.mech.ubc.ca/Faculty/Labs/IAL/index.html>

The Industrial Automation Laboratory (IAL) of the Department of Mechanical Engineering, at the was established in 1988, primarily to carry out research and development activities related to the Natural Science and Engineering Research Council (NSERC) Chair in Industrial Automation. Funding for the activities of the laboratory has been provided by many organizations including B.C. Packers, Ltd., NSERC, UBC, B.C. Hydro, Advanced System Institute of B.C., Science Council of B.C., Ministry of Environment of B.C., and the Network of Centers of Excellence: The Institute for Robotics and Intelligent Systems (IRIS). We are affiliated with the Center for Integrated Computer Systems Research (CICSR) and are located in beautiful Vancouver, British Columbia, on the west coast of Canada.

Goal

The main goal of the Industrial Automation Laboratory is the development and application of advanced technologies for industrial automation, with emphasis on robotics, machine vision, and intelligent control. Many of the recent projects have involved the development of automated machinery for the fish processing industry.

Address

Department of Mechanical Engineering
University of British Columbia
2324 Main Mall
Vancouver, B.C., Canada
V6T 1Z4

Tel: 604-822-3147 (CEME LAB)
Tel: 604-822-4850 (CICSR LAB)
Fax: 604-822-2403

Manufacturing Automation Laboratory

1. Milling Process Simulation Software

MillPro is a user friendly interactive simulation tool for predicting the performance of milling operations for a given material, cutter geometry and cutting conditions.

More information is available at www.mech.ubc.ca/~mal/research/millpro/millpro.html

2. Intelligent Machining Module

IMM is a modular DSP software development platform designed for engineers and researchers who wish to implement their real time control and monitoring algorithms quickly. IMM consists of plug and play library functions which can be extended by the users. Users with limited or no programming experience can rapidly implement real time measurement and control applications using IMM's standard run-time library functions.

More information is available at <http://www.mech.ubc.ca/~mal/research/ims.html>

3. Open System Computer Numerical Controller

The MFIO-B three-axis motion control board is ideal for motion control research. The concept and initial design were developed under the guidance of Dr. Yusuf Altintas and Dr. M. Ito at the University of British Columbia, Manufacturing Automation Laboratory.

More information is available at <http://www.mech.ubc.ca/~mal/research/numerical1.html>

University of Calgary

Department of Mechanical and Manufacturing Engineering

This department maintains a website at www.enme.ucalgary.ca/

The research activities of the Manufacturing Engineering Division are concerned with the development of the next generation of Computer Integrated Manufacturing (CIM) systems (otherwise known as Intelligent Manufacturing Systems). Current research interests include:

1) Concurrent engineering

Research in this area focuses on using information systems to facilitate design for economic manufacturing; to characterize existing and novel manufacturing processes; to model feature-based products; and to engage in process planning (integrating a product model with a CNC machine tool and a coordinate measuring machine).

2) Manufacturing system design

Research in this area focuses on the modeling and design of cellular manufacturing systems (using mathematical optimization, clustering algorithms, objective-based neural networks, and knowledge based systems); on the integration of modeling and analysis techniques for rapid system design (discrete event simulation, queuing theory, control theory, mathematical programming, knowledge-based systems); and on artificial intelligence (robot task planning system for sensor-guided inspection and assembly).

3) Decision Making and Control:

Research in this area focuses on defining an "intelligent" agent for decentralized yet integrated decision making (based on AI and object-oriented programming); on the analysis of alternative decision architectures (hierarchical and heterarchical); on real-time control paradigms (Petri nets, formal languages, knowledge-based systems); and on dynamic, finite capacity scheduling using simulation.

4) Control Systems Analysis and Design

Research in this area focuses on the modeling of dynamic systems, the specification of system and controller performance requirements (including assessment of performance limits) and controller synthesis techniques; on applications in manufacturing and machining systems and control of other devices, processes and mechanisms.

The research activities are well supported by both advanced hardware and software including: a CNC machining centre, a CNC lathe, industrial robots, a network of SUN microsystems high performance computing workstations, powerful software packages for CAD (including solid modeling), system simulation (SLAMSYSTEM, SIMAN), finite element analysis, analytical modelling, and artificial intelligence (Smalltalk, HUMBLE). In addition, graduate students have access to the new "Hewlett-Packard Intelligent Manufacturing Research Laboratory", which houses a number of state of the art high performance UNIX and 486 microcomputers running a wide range of software packages.

University of Western Ontario
Concurrent Engineering & Agile Manufacturing Research Laboratory (CEAMRL)
<http://hyperserver.engrg.uwo.ca/ceamrl/contact.htm>

The mission of the Concurrent Engineering and Agile Manufacturing Research Laboratory (CEAMRL) is:

- to pursue leading-edge applied research to identify, develop and apply tools and technologies to support world-class Canadian manufacturing in the 21st century
- to develop and implement innovative approaches to engineering education to prepare students for successful careers in the new economy, and to provide Canadian companies with the skilled engineers they need to thrive in the global marketplace.

A new paradigm known as agile manufacturing has emerged to enable companies to thrive in an environment of constant, unpredictable change. Agile manufacturing integrates people, technology and organization to achieve an interdisciplinary, collaborative approach to the entire production development cycle. Effective cross-functional concurrent engineering teams supported by information technology are a key to agile manufacturing competitiveness.

Research Offerings

Automated Path & Sequence Planning for Co-ordinate Measuring Machines
Virtual Collaboration Environment for Concurrent Engineering

Address

Concurrent Engineering and Agile Manufacturing Research Laboratory
Department of Mechanical and Materials Engineering
The University of Western Ontario
London, ON
N6A 5B9

Contact

Ralph Buchal, Ph.D,P.Eng, Director
Phone: (519) 679-2111 ext. 8454
Fax: (519) 661-3020
e-mail: rbuchal@julian.uwo.ca

Mechatronics Research Laboratory

Mechatronics is the synergistic integration of mechanical engineering with electronics and control in the design and manufacture of intelligent products and processes.

Modern manufacturing systems, as well as many consumer products, depend on the harmonious blending of several different technologies. Mechatronic engineers seek to achieve optimum performance of the electromechanical subsystems by effectively integrating the domain and design knowledge from three overlapping, but clearly distinct, engineering disciplines. To create successful mechatronic designs, engineers must balance a system science view of the product function with a solid understanding of the physical components that make up the product.

Mechatronic design involves the talents of a multidisciplinary group of engineers who clearly understand the interdependency of their design decisions. By working as a cohesive group, mechatronic designers can produce novel, high-technology products that meet specifications which were previously unattainable or even unthinkable.

The recently established Mechatronics Research Laboratory in the Faculty of Engineering Science at the University of Western Ontario promotes and supports interdisciplinary research in advanced design of intelligent products and processes. The laboratory's mandate is to offer faculty members and graduate students the opportunity to engage in applied mechatronic research that is relevant to manufacturing industries.

Current Research in Mechatronic Technology

(i) Rapid Product Development

- Spatial packing techniques that optimize the orientation and placement of three-dimensional parts in a layered manufacturing process
- Development and implementation of STEP standards for a variety of manufacturing applications
- Reverse engineering and the manufacture of customized orthopaedic implants from CT imagery

(ii) Machine vision and Environment Modeling

- Qualitative motion constraint technique for detecting independently moving objects by mobile camera systems.
- Robust technique for registering multiple range views based solely on the measured surface properties. Methods for integrating multiple views into a coherent three-dimensional CAD model are also being investigated
- Reconstruction of surface models from dense coordinate data using Bernstein basis function (BBF) neural networks.

(iii) Mechatronic System Design

- Robotic camera systems for inspecting the surfaces of cables and pipes.
- Rotary positioning device actuated by shape memory wires.

Contact

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Mechatronics Research Laboratory
Department of Mechanical & Materials Engineering
Faculty of Engineering Science
The University of Western Ontario
London, Ontario Canada, N6A 5B9

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Fax: (519) 661 - 3020

Email: gknopf@eng-ntadmin.engga.uwo.ca

University of Waterloo

Department of Mechanical Engineering

The department maintains a webpage at <http://mecheng1.uwaterloo.ca/>

Automation and Control

The Group, which also includes the Sensor System Laboratory, is engaged in a broad range of research activities related to automation and control of manufacturing processes. Automation and control engineering ranges from the control of flexible arm robotic devices, through automated guided vehicles research, to application of CIM techniques for the textile industry. In addition, basic research is carried out on problems of signal processing for machinery diagnostics, machine tool chatter, and modal analysis of structures.

Materials Engineering and Processing Group

The research performed in this group is directed toward extending the properties and limitations of materials and to developing new materials, materials processing techniques and materials joining techniques. Research in materials processing and materials joining techniques includes work in solidification, metal working, welding, surface treatments, composite materials and intermetallic alloys. Materials property studies emphasize fracture mechanisms, fatigue, fatigue-creep interactions, and the mechanical behaviour of composites and intermetallics.

Fluid Mechanics

The research of the Fluid Mechanics Group includes experimental and analytical investigation of a broad class of fluid mechanics problems. Projects underway at present relate to measurements and modeling of complex turbulent shear flows, environmental flows and reacting turbulent flows. The detailed physics of these flows is studied using a combination of advanced experimental techniques and computational fluid dynamics. General fields of application of the research programs include air pollution modeling, manufacturing processes, industrial fluid mechanics, fire behavior, combustion processes, and power systems.

Solids Body Mechanics and Mechanical Design

A major goal of this research group is to develop techniques for the design, analysis and simulation active in the areas of pressure vessels for both low and high pressures, plastic gearing, nuclear components and piping, mechanisms and mechanics, dynamic machinery, and design using computer graphics.

Fundamental work is carried out in plasticity theory and its application to bifurcation problems in manufacturing. The group is also involved in basic research in kinematics, dynamics and control of flexible robot arms. Extensive laboratory simulations, testing and non-destructive inspection are used

to study failure modes and design improvements. These studies are supported by the development of analysis techniques in computer aided design, simulation techniques, finite element methods, failure analysis, plasticity, and continuum mechanics.

Thermal Engineering

The Thermal Engineering Group conducts analytical, computational, and experimental research on a wide range of problems involving thermodynamics, heat and mass transfer and fluid flow that are of fundamental and practical importance. Current research topics include combustion, heating, ventilation and air-conditioning of buildings; energy conversion systems and devices such as engines and fuel cells; alternative fuels; liquid atomization, sprays; conduction, convection and radiation; solar energy collection and conversion; numerical methods development, and heat transfer aspects associated with microelectronic devices and packaging.

Contact

Dr. Roy Pick

rjpick@engmail.uwaterloo.ca

University of Windsor

Intelligent Manufacturing Systems (IMS) Centre

A web site for this Division is maintained at <http://www.ims.uwindsor.ca>

The Intelligent Manufacturing Systems Centre consists of the Integrated Design and Manufacturing (IDM), the Flexible Automation and Robotics (FAR), and the Advanced Manufacturing Research (AMR) Laboratories.

Service/Knowledge - Integrated Design and Manufacturing Laboratory
Laboratory Services - Flexible Automation and Robotics Laboratory

Address

University of Windsor
Intelligent Manufacturing Systems (IMS) Centre
Dept. of Industrial and Manufacturing Systems Engineering
Faculty of Engineering, University of Windsor
Windsor, ON
N9B 3P4

Contacts

Dr. Waguih H. ElMaraghy
Prof., Dept. of Indust. & Man. Syst. Engineering
Phone: (519) 253-4232 ext. 5037
Fax: (519) 971-3656
e-mail: wem@ims.uwindsor.ca

Microelectronics and Signal Processing Lab

A web site for this Division is maintained at <http://www.vlsi.uwindsor.ca>

The Microelectronics and Signal Processing Lab specializes in architectures and VLSI circuits in the areas of high performance data stream DSP and pattern recognition and signal processing using neural networks.

Research Offerings

Artificial and Cellular Neural Networks Implementations
VLSI Circuits and Systems for High Performance DSP

Address

University of Windsor
Microelectronics and Signal Processing Lab
Department of Electrical Engineering
401 Sunset Avenue
Windsor, ON
N9B 3P4

Contact

Dr. G. A. Jullien
Phone: (519) 253-4232 ext. 2574
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e-mail: jullien@uwindsor.ca

University of Toronto

Advanced Manufacturing Technologies and Processes Research

Areas of Research

- Rapid prototyping and manufacturing: The production of functional plastic, metallic and/or ceramic parts using lasers.
- Manufacturing of microcellular plastics: Development manufacturing technologies and systems for the production of micro-cellular plastics in extrusion and injection molding that have high toughness, high impact strength and long fatigue life.
- Die and mold design.
- New blowing agent development.
- Solubility and diffusivity measurement.

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Robotics and Automation Laboratory Research

<http://www.mie.utoronto.ca/labs/ral/RAL01.htm#ral>

The Robotics and Automation Laboratory (RAL) and Mechatronics Laboratory (ML) have been established in 1982 and 1995, respectively. They both share a common mandate:

- to conduct fundamental and applied research in the science of robotics and automation;
- to educate at the graduate and undergraduate levels in the field of robotics and automation; and
- to conduct industrial research and development under contract.

The Robotics and Automation Laboratory research activities focus on real time control of robots, computer-integrated manufacturing, adaptive control, redundant axes robots, hierarchical control of manufacturing processes, design and integration of sensors, and industrial contacts.

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Rapid Manufacturing Laboratory

<http://www.mie.utoronto.ca/labs/park/rapidlab.html>

The goal of the research project is the development of a novel technology for rapid manufacturing of fully functional products. A variety of free-form rapid fabrication techniques such as selective laser sintering (SLS), stereolithography (SLA), laminated object manufacturing (LOM), and other 3D printing techniques have been utilized to manufacture non-functional prototypes for visualization and design verification. Although some techniques do exist for manufacturing functional products by using the prototypes, these techniques require a number of different time-consuming process steps. The purpose of this project is to form a scientific and engineering basis needed to directly produce fully functional products based on a layer-by-layer additive manufacturing technique.

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Enterprise Integration Laboratory
<http://www.eil.utoronto.ca/#overview>

The Enterprise Integration Laboratory (EIL) research will enable businesses to develop, manufacture, sell, deliver and support products and services with unprecedented speed, flexibility, quality and economy. This is achieved through the application of business practices and technologies that create a business infrastructure enabling the dissemination of information, coordination of decisions, and management of actions to and among people and systems within the organization and outside of it. EIL research explores the creation of Enterprise Integration concepts in a bi-directional manner, in that it is simultaneously theory and application driven; an underlying philosophy to this research is that solving real problems leads to breakthrough research.

Theories

Enterprise Modeling
Multi-Agent Systems
Enterprise Information Architectures
Coordination Theory
Constraint-Directed Scheduling

Applications

Enterprise Engineering
Design-in-the-Large
Integrated Supply Chain Management.

Design and Manufacturing Integration

This lab maintains a webpage at <http://www.mie.utoronto.ca/labs/dmil/index.html>

To meet increasingly industrial needs for an engineered product such as decent quality, superior functionality, high reliability, flexible customization, short lead time and low cost, research is aimed to explore and develop innovative engineering technologies for Integrated Product Design and Manufacturing so as to facilitate market-driven, lifecycle concerns of product development.

1. With advocacy of concurrent engineering, the role and impact of multidisciplinary teamwork become significant and indispensable; however, the formal, systematic teamwork strategy and technology are either absent or inefficient.
2. Most of currently available design and analysis tools/software are suited for uses only in the latter stages of a design cycle. Many of them are neither applicable nor appropriate to team-based design and manufacturing application scenarios.
3. Traditional product development is essentially an over-the-wall approach in a serial step-by-step manner. This causes either a gap or a delay for the communications between design and manufacturing teams.

Objective

1. To develop a scientific base, cutting-edge yet cost-effective engineering tools and computer integrated systems to effectively support and facilitate multifunctional team engineering.
2. To advance computerized tools/ smart systems for integrated design and manufacturing with aim at the lifecycle concerns of product development, including the exploration of Internet-enabled CAD/CAM/CAE.
3. To bridge the gap between design and manufacturing practice through concurrent engineering by incorporating manufacturing concerns into the early design stages of a product development cycle.

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Mechatronics & Position Control System Laboratory

Various industrial applications require mechanical systems to be positioned, in response to process conditions, with very high accuracy and at very large speeds. The positioning/compensation systems needed to satisfy the industrial requirements must be capable of simultaneously offering adequate stiffness and positioning accuracy, large bandwidth, long travel range, and robustness. The simultaneous realization of these industrial requirements can be achieved for many applications through the development and integration of the following two equally-important system components:

Hardware: Precision positioning and on-line compensation systems driven by piezo-ceramic actuators.

Software: The capability to characterize and predict the behavior of the industrial systems in real-time.

The objective of this research program is to develop and integrate these two system components.

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Microplastics Manufacturing Laboratory

<http://www.mie.utoronto.ca/labs/park/polymerlab.html>

The goal of the research is the development of innovative technologies for the cost-effective manufacture of microcellular foamed plastics with superior mechanical properties. Microcellular plastics are foamed plastics characterized by cell densities greater than $1E9$ cells/cc and fully grown cells smaller than 10 micrometers. Typically, microcellular plastics exhibit high impact strength (up to a five-fold increase over unfoamed plastic), high toughness (up to a five-fold increase over unfoamed plastic), and high fatigue life (up to a fourteen-fold increase over unfoamed plastic). Because of these unique properties, a large number of innovative applications of microcellular plastics can be imagined.

These include food packaging with reduced material costs, airplane and automotive parts with high strength-to-weight ratio and acoustic dampening, sporting equipment with reduced weight and high energy absorption, insulative fibers/filaments for fabric, molecular grade filters for separation processes, surface modifiers for low friction, and biomedical materials.

Over the past decade, substantial research and development have been conducted to gain knowledge about the physical phenomena governing microcellular processing and the properties of microcellular polymers. Although this knowledge has led to the implementation of some batch processes and the structure and property characterization, continuous manufacturing processes have not been developed extensively.

In this context, research efforts in our group have been focused on the formation of the scientific and engineering basis needed to cost-effectively produce microcellular foamed plastics in various processes such as extrusion, injection molding, and rotational molding. We have successfully produced microcellular foamed materials of using PE, PP, ABS, HIPS, PS, and several proprietary semicrystalline polymers in extrusion using Carbon Dioxide as a blowing agent. All the critical processing parameters for the control of cell nucleation and volume expansion have been identified, and by tailoring the parameters, microcellular foams with a cell density greater than $1E10$ cells/cc and a controlled expansion ratio in the range of 1.5 to 43 were obtained.

Research efforts are also made to enhance the foamability of plastic resins in terms of volume expandability, cell nucleability, melt strength, surface quality, etc. in the conventional foam processing that uses a long chain blowing agent such as butane or pentane.

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Computer Integrated Manufacturing Laboratory

Computer Integrated Manufacturing (CIM) embodies three components essential to the implementation of flexible design & manufacturing -- the means for information storage, retrieval, manipulation and presentation; the mechanisms by which to sense state, and modify substance; and the methodologies by which to unite them. The Computer Integrated Manufacturing Laboratory (CIMLab), founded in 1987, provides students and research associates with necessary facilities to contribute to the success of this goal.

Research Projects

Manufacturing Control

- Supervisory Control of Manufacturing Systems

Autonomous Robotics

- Mechanisms
- Multi-Arm Robots
- Robotic Interception of Moving Objects
- Robotic Sensors
- Robotic Vision

Design & Manufacturing

- Design
- Rapid Prototyping

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Computer Integrated Manufacturing Laboratory
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M5S 3G8
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Simon Fraser University

Intelligent Robotics and Manufacturing Systems

A web site for this Division is maintained at <http://fas.sfu.ca/css/groupslis.html>

Research is focused on robotics, machine sensing and intelligent control -- with applications to manufacturing automation, service robots, and rehabilitation engineering. Students and research staff in the laboratory collaborate with industry on a variety of topics including sensor-based control, robotic workcell development, mobile robot navigation, programmable tooling for automated assembly, and Holonic Systems in intelligent manufacturing.

Offerings

- Test Equipment

 - Facilities

- Research

 - Development Projects

 - Flexible Tooling for Agile Assembly

 - Flexible Workcell Design for Assembly of Hydraulic Steering Systems

 - Global Manufacturing Data Communication Infrastructure

 - Holonic Handling Systems: Generic Activity Model of a Holon

 - Multifingered Robot Hands: Grasp Planning and Experimental Validation

 - Overview of IRIS Theme: Machine Sensing

 - Real-Time Control System for a Dextrous Robot Hand

 - Sensor-Based Manipulations: Task-Oriented, and for Discrete Assembly

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 - École Polytechnique de Montréal

 - Applied Polymer Research Centre (CRASP)

Aerospace

Carleton University

Department of Mechanical & Aerospace Engineering

<http://www.mae.carleton.ca/index.html>

The Department conducts research in design-manufacturing (design methodology, stress, vibration, fatigue, and fracture analysis of machines and structures) and in thermal fluids engineering (aerospace and energy field).

The Mechanical degree program has been in existence since the early 1960s and has been the core strength of the department upon which other developments in the graduate and undergraduate areas have taken place. From its beginnings, the department has had a history of aeronautical engineering activity and has offered master's (M.Eng.) and doctoral (Ph.D.) degrees since 1965. In 1988 the undergraduate Aerospace program was started and was the first fully dedicated bachelors degree program in the country.

Members of the faculty have an exceptionally strong industrial background in a wide variety of industries, including gas turbines, aircraft, spacecraft, ground vehicles, fabrication, manufacturing, nuclear power, and in applied research establishments on both sides of the Atlantic. This background adds a great variety and experience to teaching and is demonstrated in the choice of research projects, the majority of which are highly mission oriented, and are often carried out in conjunction with, and financially supported by, an industrial user. As a result of all this the department enjoys substantial research funding.

In 1983, this department and the Department of Mechanical Engineering at the University of Ottawa established a joint institute for graduate studies and research. The Ottawa-Carleton Institute for Mechanical and Aerospace Engineering (OCIMAE), combines the graduate programs and research strengths of both departments and is one of the largest programs of graduate studies and research in mechanical and aerospace engineering in Canada.

Research Programs

Departmental research emphasizes the three broad academic areas of design-manufacturing, mechanics-materials, and thermal-fluid engineering.

The design-manufacturing area includes: design methodology, computer-integrated manufacturing and the modelling of manufacturing processes including formability of metal sheet and welding and casting processes.

The mechanics-materials area includes:

- stress, vibration, fatigue, and fracture analysis of machines and structures, including lightweight and off-shore structures
- smart structures; spacecraft dynamics and control
- vehicle performance and dynamics, robotics and automation, intermetallics and superalloys for gas turbine applications at elevated temperature and the fabrication of titanium metal matrix composites.

Research in thermo-fluids is concentrated in the aerospace and energy field, with emphasis on gas turbines and turbomachinery, propellers and rotors, aircraft aerodynamics, and energy conversion.

Funding from Natural Sciences and Engineering Research Council of Canada (NSERC) in particular, individual research grants, is the solid foundation of the Department's research activities. This NSERC support is crucial because it provided continuity and flexibility, permitting rapid movement into new and perhaps unforeseen research opportunities.

The Department attracts substantial funding in the form of research contracts. Contracts are for specific research projects, and are often of relatively short duration. They enable a higher level of research activity than would otherwise be possible, thus enriching the educational environment; moreover, this enhances technology transfer between the University and outside organizations. Success in attracting contracts often rests on research initially funded by NSERC grants.

An outgrowth of the Department's research activity has been the development of two highly successful short courses for professional engineers, one on gas turbine performance and design, and the other on terrain vehicle systems analysis. Both attract professionals from across Canada, the U.S.A., and Europe.

Recent graduate study and research activities have included collaborative work with several laboratories of the Institute for Aerospace Research at the National Research Council, the Canadian Space Agency, the Atomic Energy Control Board, Natural Resources Canada, Agriculture and Agri-Food Canada, Materials and Manufacturing Ontario, Pratt and Whitney Canada Inc., and the Department of National Defence.

Offerings

Service/Knowledge

Gas Turbine Research Laboratory

Inertial Navigation Laboratory

Inertial Navigation Organized Research Unit

Materials and Structural Integrity Research Unit

Short Intensive Course on Gas Turbine Performance and Design

Software for the Joining Industry

Transportation Technology Research Laboratory (TTRL)

Research

Design Environments for Die Castings

Gas Turbine Theory

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McGill University Institute of Air and Space Law

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Aerodynamic Research Lab, Department of Mechanical Engineering

Webpage www.mecheng.mcgill.ca/Research-Laboratories/Aerodynamics/AeroDynamics.html

Research Projects

1) Wing-Tip Vortex Measurement:

In this project both the axial and tangential velocity distributions of the growth and development of the wingtip vortices in the near wake region of an airfoil model are investigated using the particle-image velocimetry and also a three-sensor hot-wire probe. Vorticity and Reynolds shear stress distributions are also obtained. These measurements

are then used to validate the CFD predictions provided by the Advanced Aerodynamics Group of Bombardier Inc., as well as for the possible manipulation of these vortices.

2) Measurements of the Unsteady Boundary Layer Developed on an Oscillating Airfoil:

The state and the spatial-temporal progression of the separation of the unsteady boundary layer developed on an oscillating NACA 0012 airfoil is measured nonintrusively using multiple, hot-film sensor arrays. These measurements are important in the understanding of the unsteady separated flows, especially those occurring on high-alpha maneuvering aircraft, and their manipulation.

3) Measurements of the Boundary Layer Developed on a Rotational Oscillating Circular Cylinder:

In this project, the vortex formation process and the behavior of the unsteady boundary layer developed on a rotationally oscillating circular cylinder are examined at selected oscillation frequencies and amplitudes. Special emphases are placed on the nonintrusive measurements of the instantaneous locations of the stagnation, and the upper and bottom separation points, and on the growth and development of the separated shear layers under the influence of cylinder rotation.

4) Airfoil Boundary-Layer Transition and Laminar Separation Bubble Detection:

The onset and end of the laminar-to-turbulent transition of the boundary layer developed on a stationary airfoil model at low Reynolds numbers is investigated using the multiple hot-film sensor array together with the laser Doppler velocimetry technique. The location and characteristics of the laminar separation bubble is also measured. Unique post-processing software is also being developed so as to analyze the multi-channel output signals more efficiently.

5) Two-Dimensional Backward-Facing Step Flow Experiment:

The first part of this project is concentrated on the nonintrusive measurements of the locations of the reattachment and the separation points on the bottom and upper walls behind a two-dimensional step, respectively, using multiple hot-film sensor arrays. Hot-wire anemometry, laser Doppler velocimetry, and smoke-wire flow visualization techniques are also employed to supplement the hot-film measurements. These results are also used to validate the CFD predictions. The 2nd part of this experiment is to characterize the effects of the forced flow-induced vibration on the reattachment length as well as the flow structure by oscillating sinusoidally the floor downstream of the step at selected frequencies and amplitudes.

6) Airfoil Multi-Point Skin Friction Measurement:

The measurement of the wall shear stress distribution along an airfoil model both simultaneously and nonintrusively plays an important role not only in the development and design of advanced aircraft, but also in the CFD model validation. In this project, apparatus and/or techniques capable of calibrating the multiple hot-film sensors, wrapped around an airfoil model, nonintrusively and in situ, are studied.

7) Turbulence and Transition Control Project:

In this project, both active and passive experimental implementations are re-examined and utilized to suppress the near-wall coherent turbulent flow structures which lead to turbulence production and noise. Special emphasis will be placed on the exploration of the possible drag reduction mechanisms, which is responsible for the large portion of the energy expenditure for the commercial aircraft, by the development of new technological turbulent drag reduction schemes.

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University of Toronto - Institute for Aerospace Studies

This department maintains a website at <http://www.utias.toronto.edu/>

The Institute for Aerospace Studies offers a comprehensive program in aerospace science and engineering to both undergraduate and graduate students at the University of Toronto. At the graduate level UTIAS offers research-intensive programs leading to M.A.Sc. and Ph.D. degrees, and a professionally-oriented program leading to the M.Eng. degree; the latter can be taken on a part-time basis.

The education function of UTIAS is complemented by an intense research effort recognized both nationally and internationally. The scope of research includes multidisciplinary core competencies that are being applied to the technological needs of the aerospace sector. It is the high-technology and multidisciplinary nature of ITUAS's mission that has led to an expansion of the scope of research activities and enabled an extension of research contributions to high-tech non-aerospace applications.

Being mission-oriented has led to UTIAS establishing extensive collaborations with industries in the aero and space sectors -- the users of products: highly trained manpower and new knowledge. The Institute plans on strengthening and expanding the existing interactions. At present, UTIAS participates in two Ontario and two Canadian Centres of Excellence, with the aim to continue its role as a key research/training element of the Canadian/Ontario aero and space efforts.

New projects include:

- the "Technology Road Map" [formulated by the Ontario Aerospace Council and Industry Canada]
- the "Canada Foundation for Innovation [CFI]" [aimed at strengthening university research infrastructure]
- the "Ontario Research and Development Challenge Fund [ORDCF]" [also aimed at supporting research activities].
- A joint collaboration with Dynacon Enterprises Inc., the Canadian Space Agency, and CRESTech in establishing a "MicroSatellite Technology Program" at UTIAS. This initiative will considerably enhance the Institute's activities in "Space-Systems Engineering."

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Appendix 5 – Companies

Advanced Manufacturing - Companies

The goal of automation is to produce a quality part in the least amount of time using the least amount of energy and resources. Because each manufacturing facility differs from the next, automation technology must be application specific, with each solution tailor-made for the best end result. Canadian AMT are applied in the Aerospace, Automotive, Electrical, Environmental, Fabrication, Food Processing, Forestry, Forming, Furniture, Mining, Oil / Gas / Petro-Chemical, Packaging, Pulp & Paper, Rubber and Plastic Parts, Steel Mills and Transportation industries.

What follows is a listing of the types of Advanced Manufacturing Technologies that are being used by Canadian companies. More on these companies can be found on the Strategis website at http://www.strategis.ic.gc.ca/sc_indps/sam/engdoc/sam2_hpg.html

Adaptive Control Systems

Haptic Technologies Inc.

Adaptive Process Automation

Haptic Technologies Inc.

Servo-Robot Inc.

Advanced Machine Tools

Brown Boggs Foundry and Machine Company Limited

Cobra Machine Tool Co. Ltd.

Nickleson Machine & Tool

Advanced Tooling for Manufacturing Applications

Accurate Mould Company Limited

Aerowood Tool Company

Alta Precision Inc.

Bernard Mould

BTM Tooling Inc.

Cavalier Tool and Manufacturing Ltd.

Diamond Productions Canada Ltd.

Master Machine (Windsor) Ltd.

Modelex

New Era Tool & Die Ltd.

STEVESTED Machinery & Engineering Ltd.

Zygo Mould Limited

Advanced Welding Systems

CenterLine (Windsor) Limited

Agile Manufacturing

B.R.I.C. Enterprises Inc.

Automated Assembly Systems

Almach Machinery Inc.

Automation Devices Canada Limited

Automated Systems Incorporated

ABB Olofstrom Automation Ltd

Flow Automation

Kingsbury Canada Inc.

Nickleson Machine & Tool
Opcode Systems Inc.
Stromag (Niagara) Ltd.
The Amara Company Limited
Valiant Machine & Tool Inc.
Xiris Automation Inc.

Automated Coil Handling

Colt Automation Limited

Automated Data Collection

AURORA bar code technologies ltd.
KLN Klein Product Development Inc.
Symcod Inc.

Automated Die Handling

Orchid International

Automated Inspection Systems

Cabletest International
Diffracto Ltd.
Armstrong Monitoring Corporation
Servo-Robot Inc.

Automated Machining

Alta Precision Inc.
Diamond Productions Canada Ltd.
New Automation Corporation
Nickleson Machine & Tool

Automated Material Handling Systems

Advanced Dynamics Corporation
Automation Devices Canada Limited
Berg Chilling Systems Inc.
Bevco
Cymat Technologies Inc.
FANUC Robotics Canada, Ltd.
Flow Automation
Handling Specialty
Mega Industries Inc.
New Automation Corporation
Pacline Corporation
Pneueyor Systems Limited
RMT Engineering Ltd.
TOPS Conveyor Systems Inc.
Valiant Machine & Tool Inc.
Vilo Systems Inc.
Zarpac Inc.

Automated Packaging Systems

Almach Machinery Inc.
Fillab Inc.
General Conveyor Co. Ltd.
G.N. Packaging & Equipment

Kalish
Wulftec International Inc.
Zarpac Inc.

Automated Systems - Press Form Application
Orchid International

Automated Storage and Retrieval Systems
Orchid International
Jervis B. Webb Company of Canada, Ltd.

Automated Testing Systems
Cabletest International
Dipix Technologies Inc.

Automated Welding Systems
Almach Machinery Inc.
CenterLine (Windsor) Limited
FH Welding Machine Limited
Liburdi Engineering Ltd.
Rumble Automation Inc.
Valiant Machine & Tool Inc.

Automatic Identification
Lasiris
Symcod Inc.

Automatic Welding Systems
CenterLine (Windsor) Limited

Automation Systems
VALMET Automation
KLN Klein Product Development Inc.
Microtrol Inc.
Pneueveyor Systems Limited

Blank Holder
Orchid International

Blown Film Processors
Brampton Engineering
Macro Engineering & Technology Inc.

Blow Molds
Blow Mold Tooling Inc.
Modelex
Ryka Blow Molds Ltd.

Boundary Testing System
Acculogic Inc.

Bulk Handling Systems
Berg Chilling Systems Inc.
Pneueveyor Systems Limited

Ramsey Canada

CAD/CAM

XYZ Automation Inc.
Beck Technology Inc.
Famic Inc.
Haptic Technologies Inc.
In-House Solutions Inc.
KLN Klein Product Development Inc.

CAD/CAM/CAE Hardware

Haptic Technologies Inc.

CCD Camera-based Web Inspection Systems

Mayan Automation Inc.

CCD Image Sensors

Lasiris

Casting Equipment

Advanced Dynamics Corporation

Casting Tooling Technology

Valiant Machine & Tool Inc.

Cell/FMS Controllers

Memex Electronics Inc.

Circuit Boards

ASA Automation Systems Associates Limited
KLN Klein Product Development Inc.

Clean Room

Fillab Inc.

CNC Engine Lathe

Kestrel Machine Tools Inc.

CNC Lathe

Kestrel Machine Tools Inc.

CNC Machine Tools

Cobra Machine Tool Co. Ltd.
Kestrel Machine Tools Inc.
Quickmill Incorporated

CNC Machining Process

KLN Klein Product Development Inc.
Modelex
Omtronix Engineering Corp.

Co-extrusion Equipment

Deltaplast Machinery Ltd.
Macro Engineering & Technology Inc.

Coil Feeding Equipment

Colt Automation Limited
Lindgren Automation Inc.

Coil Handling

Advanced Dynamics Corporation
Colt Automation Limited

Components

Omron Canada Inc.

Compression Moulds

Bernard Mould
Cavalier Tool and Manufacturing Ltd.
Modelex
Redoe Mold Co. Ltd.
Weber Manufacturing Limited

Conveyors

Brandt Manufacturing Inc.
General Conveyor Co. Ltd.
Jervis B. Webb Company of Canada, Limited
Mega Industries Inc.
Pacline Corporation
Pneveyor Systems Limited
Stromag (Niagara) Ltd.
TOPS Conveyor Systems Inc.
Walsh Automation Inc.

Co-ordinate Measuring Machines

Bernard Mould

Custom Tooling

Bernard Mould
Diamond Productions Canada Ltd.
Nickleson Machine & Tool

Cutting Tools

CAE Machinery Ltd.
Diamond Productions Canada Ltd.
DynaVision

Die Casting Machines

Techmire Ltd./Ltée

Drilling Machines - CNC

Corsteel Hydraulics

Drive Systems

BC Bearing Engineers Limited
Beel Technologies Inc.

Electrical Control Systems

Keltour Controls
Wainbee Limited

Electronic Control Systems

Keltour Controls
KLN Klein Product Development Inc.

Electronic Testing

Acculogic Inc.

Encoders

KLN Klein Product Development Inc.

Expert Systems

CMS Manufacturing Systems Inc.
Cognisys Consultants Inc.
Universal Dynamics Technologies Inc.
Walsh Automation Inc.

Extruders

Brampton Engineering
Deltaplast Machinery Ltd.

Fabricating - Flexible Cells

Automated Tooling Systems Inc.
B.R.I.C. Enterprises Inc.
FH Welding Machine Limited
Prodomax Industrial Automation
Rumble Automation Inc.

Factory Automation

Automated Systems Incorporated
EPCM Services Limited
Flow Automation

KLN Klein Product Development Inc.
Mega Industries Inc.
Rockwell Automation
Symcod Inc.
Walsh Automation Inc.

Feeding Equipment

Colt Automation Limited
Mega Industries Inc.
Pneueyor Systems Limited
Stromag (Niagara) Ltd.

Flexible Manufacturing Systems

Automated Systems Incorporated
B.R.I.C. Enterprises Inc.
Flow Automation
Kingsbury Canada Inc.

Forming Machines

Brown Boggs Foundry and Machine Company Limited
FH Welding Machine Limited

Fully Integrated Assembly Systems

Kingsbury Canada Inc.

Gantry Machining Centers

Quickmill Incorporated

Gauging (CNC multi-axis gauging systems for pressbrakes and shears)
Zakron Industries Inc.

Grinding Technology

Diamond Productions Canada Ltd.

Heaters

Aerotech International Inc.

Hot Runner Systems

Tradesco Mold Ltd.

Hydraulic Control Systems

Keltour Controls

Identification Systems

Omron Canada Inc.
Symcod Inc.

Image Analysis

Kaptra Inc.
Lasiris

Industrial Controls

Dynapro
EPCM Services Limited
Memex Electronics Inc.

Microtrol Inc.
SST
Surround Technologies Inc.
Walsh Automation Inc.

Injection Moulds

Accurate Mould Company Limited
Bernard Mould
BTM Tooling Inc.
Cavalier Tool and Manufacturing Ltd.
Master Machine (Windsor) Ltd.
Redoe Mold Co. Ltd.
Tradesco Mold Ltd.
Weber Manufacturing Limited
Zygo Mould Limited

Injection Molding Machines

Blow Mold Tooling Inc.
Techmire Ltd./Ltée

Inspection Systems

Armstrong Monitoring Corporation
Cabletest International
Dipix Technologies Inc.
Fiso Technologies Inc
Kaptra Inc.
Lasiris
Mayan Automation Inc.
Ramsey Canada
Xiris Automation Inc.

Inventory Control

AURORA bar code technologies ltd.
Symcod Inc.

Instrumentation

EPCM Services Limited
KLN Klein Product Development Inc.
Nickleson Machine & Tool
Omron Canada Inc.
Walsh Automation Inc.

Jigs and Fixtures

Advance Metal Industries
CenterLine (Windsor) Limited
IRCO Automation Inc.
KLN Klein Product Development Inc.

Lapping/polishing Machines - CNC

Diamond Productions Canada Ltd.

Lasers

Lumonics Inc.
MPB Technologies Inc.

Laser Measurement Control

DynaVision
Diffracto Ltd.
Lasiris

Laser Sensors

DynaVision
Lasiris
SAMI (Sensor Adaptive Machines Inc.)

Laser - Guided Machine Vision Systems

Lasiris
Servo-Robot Inc.
Virtek Vision Corp.

Laser Imaging Systems

Bernard Mould
Escher-Grad Technologies Inc.
MPB Technologies Inc.

Lifting Systems

Handling Specialty

Machine Tools

Beck Technology Inc.
Cobra Machine Tool Co. Ltd.
Nickleson Machine & Tool
Quickmill Incorporated

Machine Vision Systems

Flow Automation
Lasiris
Walsh Automation Inc.
Xiris Automation Inc.

Machining - Flexible Cells

Kingsbury Canada Inc.

Maintenance Management Systems

Epix Inc.

Manufacturing Resource Planning

Trillium Consultants Inc.

Manufacturing Systems

Cognisys Consultants Inc.
EPCM Services Limited
Kingsbury Canada Inc.

Material Handling Equipment

BC Bearing Engineers Limited
Ball Service Group Inc.
Bectrol Inc.
Blue Giant Limited

Cougar Automation Technologies
Cymat Technologies Inc.
Flow Automation
Handling Specialty
IRCO Automation Inc.
Mega Industries Inc.
Pacline Corporation
Pneueveyor Systems Limited
Ramsey Canada
TOPS Conveyor Systems Inc.

Material Handling Systems

Cymat Technologies Inc.
Flow Automation
Lindgren Automation Inc.
Jervis B. Webb Company of Canada, Ltd.
Mega Industries Inc.
TOPS Conveyor Systems Inc.
Vilo Systems Inc.

Metal Cutting Systems

Advanced Dynamics Corporation
Cobra Machine Tool Co. Ltd.
Diamond Productions Canada Ltd.
Kingsbury Canada Inc.
Nickleson Machine & Tool
TRI-WAY Machine Ltd.

Metal Forming Equipment

Brown Boggs Foundry and Machine Company Limited

Metal Stamping

Brown Boggs Foundry and Machine Company Limited

Metrology -Gauging and Dimensional Metrology

Bernard Mould
Servo-Robot Inc.

Milling System Software

Omtronix Engineering Corp.

Molds

Accurate Mould Company Limited
Bernard Mould
Blow Mold Tooling Inc.
BTM Tooling Inc.
Canadian Association of Mold Makers Inc.
Cavalier Tool and Manufacturing Ltd.
FGL Precision Works Ltd.
Master Machine (Windsor) Ltd.
Modelex
New Era Tool & Die Ltd.
Redoe Mold Co. Ltd.

Ryka Blow Molds Ltd.
Tradesco Mold Ltd.
Weber Manufacturing Limited
Zygo Mould Limited

Modelling and Simulation Systems

Cognisys Consultants Inc.
Haptic Technologies Inc.
Modelex

Motion Control Systems

DynaMotive Technologies Corporation
Haptic Technologies Inc.
KLN Klein Product Development Inc.
Mega Industries Inc.
Memex Electronics Inc.
Microtrol Inc.

Motor Controllers

ASA Automation Systems Associates Limited
XYZ Automation Inc.
Beel Technologies Inc.
Memex Electronics Inc.
Startco Engineering Inc.

Motors

XYZ Automation Inc.

NC Post Processing Systems
ICAM Technologies Corporation

Numerically Controlled Equipment

Alta Precision Inc.
Memex Electronics Inc.

Packaging and Labelling Equipment

Aquaflex Systems Inc.
Charles Lapierre Inc.
G.N. Packaging & Equipment
IPS Automation Inc.
Kalish
Stromag (Niagara) Ltd.
Wulftec International Inc.
Zarpac Inc.

Painting Robots

FANUC Robotics Canada, Ltd.

PLC's

Omron Canada Inc.
Rockwell Automation

Piercing Machines
CenterLine (Windsor) Limited

FH Welding Machine Limited

Plasma Induction Systems - Metals/Ceramics

Tekna Plasma Systems Inc.

Plasma Spraying

Tekna Plasma Systems Inc.

Plastics Processing Equipment

Berg Chilling Systems Inc.

Deltaplast Machinery Ltd.

Tradesco Mold Ltd.

Zygo Mould Limited

Pneumatic Components

Axiom Technologies Limited

CenterLine (Windsor) Limited

SMC Pneumatics (Canada) Ltd.

Pneumatic Controllers

Wainbee Limited

Pneumatic Control Systems

Keltour Controls

Wainbee Limited

Pneumatic Conveyors

Mega Industries Inc.

Pneueveyor Systems Limited

Power Source

ASA Automation Systems Associates Limited

Power Supplies

KLN Klein Product Development Inc.

Omron Canada Inc.

Precision Engineering Systems

ASA Automation Systems Associates Limited

Precision Machining

Accurate Mould Company Limited

Alta Precision Inc.

Diamond Productions Canada Ltd.

Press Automation Devices

ABB Olofstrom Automation Ltd

Press Feeding

Colt Automation Limited

Mega Industries Inc.

Presses - Hydraulic

Brown Boggs Foundry and Machine Company Limited

CenterLine (Windsor) Limited
Corsteel Hydraulics
Valiant Machine & Tool Inc.

Presses - Mechanical

Aquaflex Systems Inc.
Brown Boggs Foundry and Machine Company Limited

Presses - NC/CNC

Brown Boggs Foundry and Machine Company Limited

Presses - Pneumatic

CenterLine (Windsor) Limited

Printed Circuit Board (PCB) Testing

Acculogic Inc.

Process Control Instruments

Bectrol Inc.
DPL Systems Engineering
Elsag Bailey (Canada) Inc.
EPCM Services Limited
Kaptra Inc.
Ramsey Canada
Scale-Tron Inc.
Sherrex Systems Limited
Universal Dynamics Technologies Inc.
Walsh Automation Inc.

Process Cooling Systems

Berg Chilling Systems Inc.
EPCM Services Limited

Process Monitoring

Cognisys Consultants Inc.
EPCM Services Limited
SAMI (Sensor Adaptive Machines Inc.)

Programmable Logic Controllers - PLC

Hinz Automation Inc.
Rockwell Automation
Walsh Automation Inc.

Prototype Moulds

Cavalier Tool and Manufacturing Ltd.
Master Machine (Windsor) Ltd.
Redoe Mold Co.Ltd.

Quick Die Change System

Orchid International

Rapid Prototyping

KLN Klein Product Development Inc.
Modelex

Remote Controlled Viewing System

Haptic Technologies Inc.

Resistance Welding

CenterLine (Windsor) Limited

Riveting Machines

CenterLine (Windsor) Limited
Corsteel Hydraulics

Robot - Controllers

RSI Research

Robotic Automation

B.R.I.C. Enterprises Inc.
FH Welding Machine Limited
Flow Automation
Microtrol Inc.
New Age Robotics & Controls Inc.
New Automation Corporation
Prodomax Industrial Automation
Rumble Automation Inc.
RMT Engineering Ltd.

Robotics

FANUC Robotics Canada, Ltd.
General Cybernetics Inc.
KLN Klein Product Development Inc.
MPB Technologies Inc.
Orchid International
Walsh Automation Inc.

Robotic Joint Tracking

Servo-Robot Inc.

Robotic Systems

Almach Machinery Inc.
B.R.I.C. Enterprises Inc.
Flow Automation
Liburdi Engineering Ltd.

Robotic Work Cells

B.R.I.C. Enterprises Inc.
Flow Automation
TransQuip Inc.

Robotic Welding

DynaMotive Technologies Corporation
FANUC Robotics Canada, Ltd.
IRCO Automation Inc.
Rumble Automation Inc.

Robots

ASA Automation Systems Associates Limited
CRS Robotics
Kinetic Sciences Inc.

Robots - used

New Age Robotics & Controls Inc.

Rolling Mill

Corsteel Hydraulics

SCADA

Hinz Automation Inc.
VALMET Automation

Seal Assembly Machines

The Amara Company Limited

Sensing Systems for Manufacturing Applications

Nickleson Machine & Tool

Sensors

ALMET Automation
KLN Klein Product Development Inc.
Microtrol Inc.
Pneueveyor Systems Limited

Blank Holder

Orchid International

Blown Film Processors

Shop Floor Data Collection
AURORA bar code technologies ltd.
Symcod Inc.

Smart Cards

Amerisys Inc.

Software

ALT-C Systems Inc.
AURORA bar code technologies ltd.
Axon Development Corporation
Berclain Group Inc.
CMS Manufacturing Systems Inc.
Cognisys Consultants Inc.
Comdale Technologies (Canada) Inc.
Dynapro
Epix Inc.
Famic Inc.
Haptic Technologies Inc.
In-House Solutions Inc.
Kinetic Sciences Inc.

Najmah Engineering Software Company
Omron Canada Inc.
Reid Productivity Systems Ltd.
Seaforth Engineering Group Inc.
SMART Technologies Inc
Software Integration Services Ltd.
Solid CAD Inc.
SST
Xiris Automation Inc.

Stereolithography

Alta Precision Inc.
Modelex

Surface Finishing Measurement Equipment

Diffracto Ltd.
DynaVision
Kaptra Inc.

Surface Inspection-3D

Hymarc Ltd.
Lasiris
Servo-Robot Inc.

Systems Integration

Axiom Technologies Limited
DPL Systems Engineering
Flow Automation
Microtrol Inc.
Opcode Systems Inc.

Test and Inspection Equipment

Brandt Manufacturing Inc.
Cabletest International
Ingénierie Electro-Optique Exfo Inc.
Nickleson Machine & Tool
SST

Thermoset Molds

BTM Tooling Inc.

Torch - Induction Plasma

Tekna Plasma Systems Inc.

Transfer lines

Kingsbury Canada Inc.

Transfer machines

Kingsbury Canada Inc.

Tube End Forming Equipment - CNC

Eagle Precision Technologies Inc.

Vibratory Finishing Systems
Mega Industries Inc.

Vibratory Bowl Feeders
Flow Automation
Mega Industries Inc.
Stromag (Niagara) Ltd.

Virtual Reality Systems
Haptic Technologies Inc.

Vision Controlled Robotic Workcells
Labotix Automation Inc.

Vision Systems
Dipix Technologies Inc.
Haptic Technologies Inc.
Hymarc Ltd.
IPS Automation Inc.
Lasiris
Liburdi Engineering Ltd.
Modular Vision Systems Inc.
Omron Canada Inc.

Water-based Cleaning Technology
Proceco Ltd.

Weighing Systems - Digital
Scale-Tron Inc.

Welding
Ball Service Group Inc.
CenterLine (Windsor) Limited
IRCO Automation Inc.

Welding Machine Process
CenterLine (Windsor) Limited
FH Welding Machine Limited

Welding Robots
FANUC Robotics Canada, Ltd.

X-ray scanning systems
Tantus Electronics Corp.

Companies – Aerospace

The following list is that of Canadian companies active in aerospace industries. Links to each of these companies can be found at the Strategis website at <http://strategis.ic.gc.ca/SSG/ad03487e.html>

Acculogic Inc.
Accurate Mould Company Limited
Aerospace Welding Inc.
Aerotech International Inc
Aimtronics Corporation
Alican Enterprise Inc.
Alta Precision Inc.
Andec Mfg. Ltd.
Anker-Holth Ltd.
Armstrong Monitoring Corporation
ASA Automation Systems Ltd.
Atlantis Aerospace Corp.
AURORA bar code technologies Ltd.
Automated Systems Incorporated
Automation Works Inc.
Avcorp Industries Inc.
Axiomatic Technologies Corp.
BASE Controls Ltd.
Beel Technologies Inc.
Berlet Electronics Ltd.
Blue Giant Limited
Brown Boggs Foundry and Machine Company Limited
B.R.I.C. Enterprises Inc.
C-MAC Industries Inc.
Cabletest International
CAD/CAM Solutions
Canadian Thermostats and Control Devices Ltd.
Carelift Equipment Inc.
CaseBank Technologies, Inc.
Castool Precision Tooling
Cavalier Tool and Manufacturing Ltd.
Cemar Electro Inc.
Centre Prototech
Cimatron Technologies Inc.
CMS Manufacturing Systems Inc.
Comdale Technologies (Canada) Inc.
Coprodev Inc.
Coreco Inc.
COSS Systems Inc.
Cryotron (Canada) Ltd.
Cymat Technologies Inc.
Diamond Productions Canada Ltd.
Diffracto Ltd.
Dipix Technologies
Dynacon Inc.
Eagle Precision Technologies Inc.
Electromate Industrial Sales Ltd.
Engineering Services Inc.
Epic Data International Inc.

Famic Inc.
FANUC Robotics Canada, Ltd.
FH Welding Machine Limited
Fiso Technologies Inc.
Fleming Systems Corp.
Flow Automation
Forming Technologies Incorporated
FSP Machinery Company Inc.
GasTOPS Ltd.
Handling Specialty
Haptic Technologies Inc.
Hitek Computer Systems
Howmet Cercast Cercor (Canada) Inc.
ICAM Technologies Corporation
Indelec Automation Inc.
In-House Solutions Inc.
Inforex
InnovMetric Software Inc.
International Minicut Inc.
International Submarine Engineering
IPS Automation Inc.
INSTRUMAR Ltd.
J.C. de la Riviere Associates Ltd.
Kestrel Machine Tools Inc.
Kinetic Sciences Inc. (KSI)
Kingsbury Canada Inc.
KLN Klein Product Development Inc.
Lasiris
Liburdi Engineering Ltd.
Lumonics Inc.
Main Plastics
Master Machine (Windsor) Ltd.
Measurand Inc.
Mega Industries Inc.
Memex Electronics Inc.
Microtrol Inc.
Modular Vision Systems Inc.
Modelex
MPB Technologies Inc.
Murdock & Associates
Nautilus International Control & Engineering Ltd.
New Era Tool & Die Ltd.
Northwest Mettech Corp.
Okanagan Precision Machine Ltd.
Omtronix Engineering Corp.
Opus Automation
ORIENTECH Inc.
Pentalift Equipment Corporation
PlannSoft Management Solutions Inc.
Pratt & Whitney Canada
Proceco Ltd.
Prodomax Industrial Automation
Pro-Tech Industrial Group Inc.
ProtoPlast Inc.

RD Corp.
ReACT Technologies Inc.
Redoe Mold Co. Ltd.
REDUCT & Lobbe Technologies Inc.
Reid Productivity Systems Ltd.
REKO International Group Inc.
RIKEN Manufacturing Inc.
Rivait Machine Tools
RMS Instruments
Robert I. Robotics Inc.
Robot Simulations Ltd.
R-Theta Inc.
Rumble Automation Inc.
SED Systems Inc.
Sensor Technology Limited
Servo-Robot Inc.
ShivaSoft Inc.
SMART Technologies Inc.
Solid CAD Inc.
SPICER Corporation
SST
Stellar Optics Research International Corporation (SORIC)
STEVESTED Machinery & Engineering Ltd.
Symcod Inc.
Tantus Electronics Corp.
Target Solutions Inc.
Techmire Ltd./Ltée
Teklogix
Tekna Plasma Systems Inc.
Tektrend International Inc.
Terra Aerospace Corporation
The Amara Company Limited
Toshiba Machine Company Canada Ltd.
TRI-WAY Machine Ltd.
Valiant Machine & Tool Inc.
Virtek Vision Corp.
Virtual Prototypes Inc.
Vitana Corporation
Vortek Industries Ltd.
Wainbee Limited
Weber Manufacturing Limited
WebPLAN Inc.
Xiris Automation Inc.
Zum Hingst Technologies