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**SECTOR  
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**AEROSPACE  
AND DEFENCE  
ELECTRONICS  
OVERVIEW  
AND PROSPECTS**

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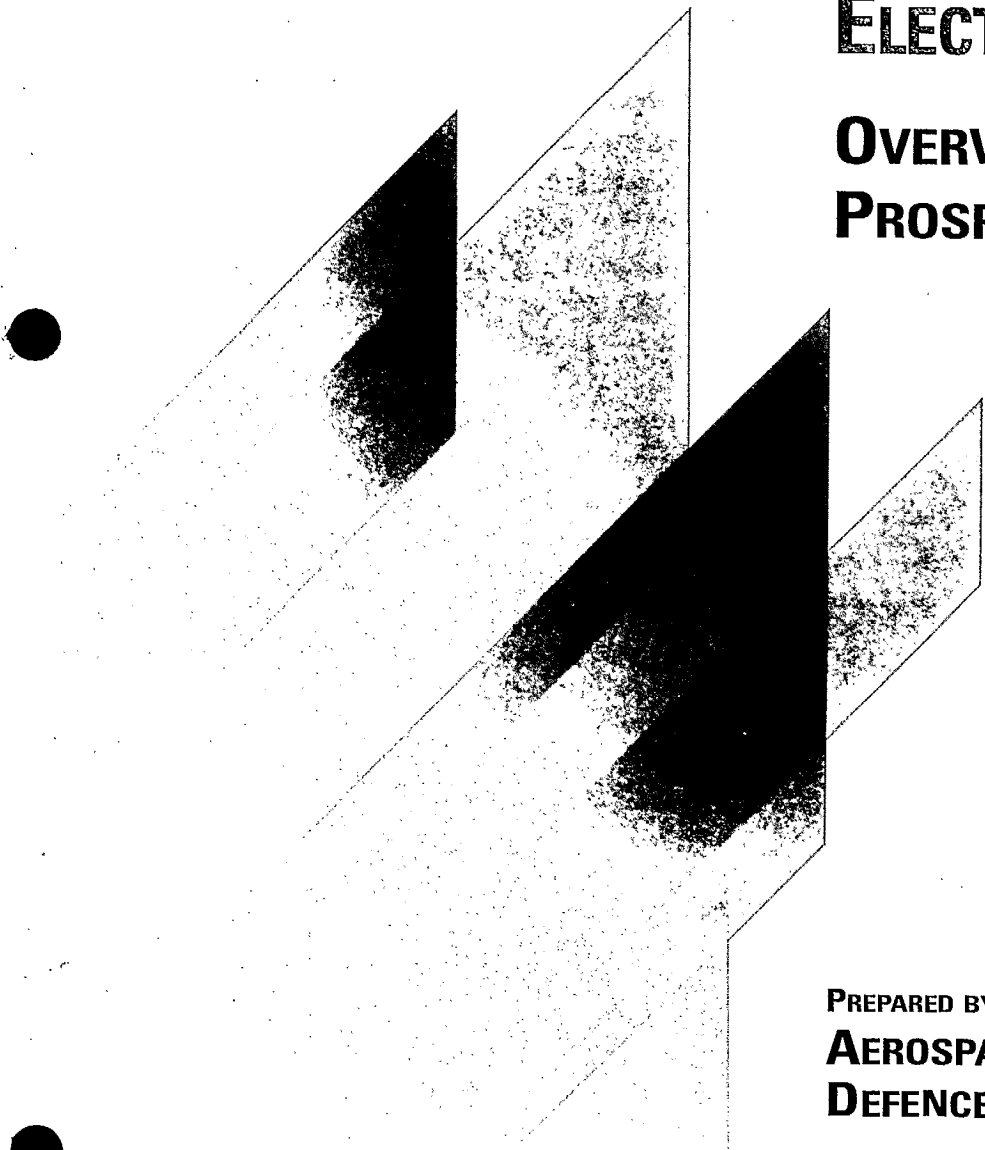
**SECTOR  
COMPETITIVENESS  
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AND DEFENCE  
ELECTRONICS  
OVERVIEW  
AND PROSPECTS**

Canada

# **AEROSPACE AND DEFENCE ELECTRONICS**

## **OVERVIEW AND PROSPECTS**



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PREPARED BY:

**AEROSPACE AND  
DEFENCE BRANCH**

This *Overview and Prospects* is the first of two companion documents on Canadian aerospace and defence electronics in the **Sector Competitiveness Frameworks** series, which is being produced by Industry Canada in collaboration with Canada's key stakeholders in the industry. *Part 2 — Framework for Action* will be prepared in coming months, based on discussions with major industry stakeholders, following study and review of the *Overview and Prospects*.

The **Sector Competitiveness Frameworks** series focusses on opportunities, both domestic and international, as well as on challenges facing each sector. The objective is to seek ways in which government and private industry together can strengthen Canada's competitiveness and, in doing so, generate jobs and growth.

*Part 1 — Overview and Prospects* is being made available for distribution in printed as well as electronic forms. In all, some 32 industrial sectors are being analyzed.

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# FOREWORD

The new Canadian marketplace is expanding from national to global horizons and its economic base is shifting increasingly from resources to knowledge. These trends are causing Canadian industries to readjust their business approaches, and government must respond with new tools to help them adapt and innovate. Industry Canada is moving forward with strategic information products and services in support of this industry reorientation. The goal is to aid the private sector in what it is best qualified to do — create jobs and growth.

Sector Competitiveness Frameworks are a series of studies published by Industry Canada to provide more focussed, timely and relevant expertise about businesses and industries. They identify sectors or subsectors having potential for increased exports and other opportunities leading to jobs and growth. They cover 32 of Canada's key manufacturing and service sectors.

While they deal with "nuts and bolts" issues affecting individual sectors, the Sector Competitiveness Frameworks also provide comprehensive analyses of policy issues cutting across all sectors. These issues include investment and financing, trade and export strategies, technological innovation and adaptation, human resources, the environment and sustainable development. A thorough understanding of how to capitalize on these issues is essential for a dynamic, job-creating economy.

Both government and the private sector must develop and perfect the ability to address competitive challenges and respond to opportunities. The Sector Competitiveness Frameworks illustrate how government and industry can commit to mutually beneficial goals and actions.

The Sector Competitiveness Frameworks are being published sequentially in two parts. An initial *Overview and Prospects* document profiles each sector in turn, examining trends and prospects. The follow-up *Framework for Action* draws upon consultations and input arising from industry-government collaboration, and identifies immediate to medium-term steps that both can take to improve sectoral competitiveness.

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**A**erospace and defence (A&D) electronics is a global industry comprising designers and manufacturers of electronic systems and components for military and commercial spacecraft and for military equipment used on land and sea. The industry also produces support systems such as air traffic management, simulation and training.

The A&D electronics industry differs from most other commercial and consumer electronics industries in a number of respects. A&D electronics products must meet exacting performance standards and/or operate in, and survive, the adverse conditions of harsh physical environments during aircraft operations, spacecraft launches or battlefield hostilities. Innovation in design thus focusses on security, reliability, accuracy, speed and durability, as well as miniaturization to reduce volume and weight. They are frequently manufactured in low volumes with limited cost benefits from economies of scale. Technological barriers to entry can be high, since product research and development (R&D) is intense and constant. Services such as software program writing, systems integration and testing, and project management form a large and increasing portion of work activities. Highly trained and specialized human resources are critical to competitiveness and are often in short supply.

The industry has its origins in government defence, space, communications and air traffic control policies and procurement. As a consequence, its dynamics have historically been defined by governments' purchasing power, their unique purchasing behaviour and their regulatory influence. Government customers have traditionally focussed on product performance. They typically pay product development costs, while generating lengthy product development cycles and stipulating unique and stringent design and production requirements that have generated high overheads for A&D electronics manufacturers.

For reasons of national security, national governments worldwide tend to adopt policies regarding their high technology industries that develop a domestic capability. Government intervention is pervasive, and industry investment and trade are heavily influenced by an array of non-tariff barriers. World production and markets are

dominated by large U.S. and European aerospace and defence conglomerates that are closely linked to the national security and high technology interests of their home governments. These competitors are supported by large domestic government budgets and preferential procurement practices.

The world market for A&D electronics is estimated at over US\$83 billion in 1997, which provides significant opportunities for Canadian companies.

The Canadian A&D electronics industry in 1997 comprised 135 establishments employing 15 000 staff. Sales that year were worth \$2.7 billion, or approximately 20 percent of Canada's total aerospace and defence-related high technology sales of \$13.4 billion. Exports were worth \$1.6 billion, or 61 percent of Canadian industry sales.

The strengths of Canada's A&D electronics industry lie in small, dual-use systems that serve both civil and military niche markets. For example, Canada is a world leader in markets for flight simulation, space robotics, satellite communication subsystems and components, and various surveillance and detection products.

Industry R&D and sales are strong generators of jobs, national income and technology for Canada. For example, A&D electronics technologies have been applied in other sectors of the economy such as intelligent transportation systems.

Over half of Canada's A&D electronics industry sales are to civil and export markets. Defence sales are focussed on simulation, surveillance, detection, and communications systems and products. Canadian companies do not manufacture large defence and space systems except to meet domestic requirements, and often serve as subcontractors for large foreign defence and space programs.

Canada's industry is characterized by significant foreign ownership, with many companies being subsidiaries of the large U.S. and European aerospace and defence corporations. Inter- and intra-firm investment and trade are therefore important for Canadian companies, with over 30 percent of industry sales going to other (for the most part U.S.) aerospace and defence corporations.



## **1.1 Major Trends**

Changes in the aerospace and defence environment pose a challenge for Canada's industry. The escalated cost of aerospace and defence systems, combined in the early 1990s with reduced government budgets and the slowdown in the airline industry, has heightened customer cost sensitivities. In response, world industry consolidation has accelerated. This in turn has forced an increased emphasis on cost considerations and on design and manufacturing efficiencies (in addition to technology performance). Canadian companies, particularly foreign-owned subsidiaries, now face more powerful competitors, customers and corporate parents who are restructuring, reducing capacity and streamlining their supplier base to achieve greater efficiencies.

Government customers are attempting to emulate the practices of commercial buyers by not stipulating stringent production specifications or overly unique product design specifications (i.e., focus on final price and performance only) and by avoiding having to pay product development costs, a trend commonly referred to as buying commercial "off-the-shelf" (COTS). This practice, along with the availability of rapidly advancing commercial hardware and software technologies, has increased the pressures on traditional A&D electronics companies by reducing the availability of government R&D resources and by allowing the incursion of more commercial competitors who have not previously served government markets.

On the other hand, commercial business practices and hardware and software inputs can reduce the cost structures of A&D electronics makers. Moreover, as government A&D missions continue to require unique, leading-edge solutions that are built to exacting standards, it is uncertain to what extent the government customer can fully emulate the practices of commercial buyers and to what extent the government customer's role as a generator of technology will be limited.

## **1.2 Growth Prospects**

Customer cost sensitivities and new missions are increasing the role of electronics in aerospace and defence products and activities, which may create opportunities for Canadian technologies and products. For example, the electronic content of aircraft will rise as electronics technologies offer ways of reducing aircraft acquisition and operating costs. Commercial markets for avionics, air traffic management equipment and space electronics are all important to Canadian prospects, and show promising growth as globalization fuels increases in air travel and communications demand.

The defence electronics segment of this market remains large despite a significant decline in the early 1990s, and is expected to experience moderate growth in coming years. Decreased government budgets have led to an emphasis on simulation rather than actual weaponry use to reduce training costs. Moreover, uncertainties regarding strategies and weaponry in use on the modern battlefield have shifted the focus toward battlefield surveillance and communications electronics. These are all areas in which Canada has strengths.

Canada's industry originated in Government of Canada defence, space, communications, and air traffic control policies and procurement. The domestic government remains an important customer, buying 27 percent or more of industry output. This market, now smaller and more competitive as a result of COTS, privatization and deregulation, will offer the Canadian industry fewer major projects and fewer opportunities for technology development (although electronics projects figure prominently in future procurement plans).

The Canadian industry is adjusting to changes in aerospace and defence markets and is poised for growth. The industry has invested in developing an array of dual-use, proprietary products suited to future growth patterns, has diversified further into civil and export markets, and has raised productivity. These growth areas may offer opportunities for Canadian A&D electronics companies, especially those niche market players who are able to combine their expertise in partnership with an industry leader to increase

their market share. Canadian industry sales have recovered from the decline of the early 1990s and, once the final 1998 figures have been tabulated, are expected to surpass their previous highs of 1991.

However, a trend toward a reduction in the industry's R&D investment as a percentage of sales may harm future growth and may be linked to reduced government R&D spending and procurement. As well, some Canadian companies remain vulnerable to world industry consolidation, commercial competition and cost pressures, particularly those that are characterized by all, or some, of the following:

- foreign ownership, with limited finance, technology and marketing autonomy
- dependence on government procurement, which is now downsized and subject to much greater competition
- a narrow defence focus, thus lagging in the adoption of new processes and depending on an overhead-laden military environment
- a lack of strong proprietary products, providing only readily available system integration and software services
- a lack of broad, strategic vision for competing internationally, thus remaining almost wholly dependent on the fading domestic market.

### **1.3 The Bottom Line**

*To meet the challenges and take advantage of growth opportunities, companies need to:*

- maintain a technologically defensible competitive advantage in a COTS environment, through R&D into leading-edge, proprietary niche systems that are in demand by aerospace and defence prime manufacturers and end users
- improve design and manufacturing efficiencies and cost-reduction strategies, by adopting, where feasible, commercial processes and utilizing suitable COTS componentry and software
- take a strategic view to make themselves attractive investments within multinational enterprises and prospective joint venture partners as world industry consolidation accelerates

- adjust to the smaller, more competitive domestic government procurement and diversify further into export and civil markets
- address skilled worker shortages through worker training and improved remuneration, and form effective industry-academic partnerships, to ensure that the next generation of post-secondary graduates are qualified to meet the high skill demands of the future
- recognize that the Canadian market will not sustain the industry, and that global competition using best practices is inevitable.

***In parallel, government has a key supportive role. In particular, it must undertake to:***

- level the international playing field for companies in Canada through stable R&D budgets, sales financing and procurement assistance where appropriate
- attract new foreign direct investment to strengthen existing niche capabilities and to develop new ones
- assist companies in gaining access to protected foreign markets and R&D budgets through industrial benefits (offsets) on government procurement and through international defence and space agreements with foreign governments
- ensure that procurement practices encourage companies to adopt the most efficient commercial best manufacturing practices
- help improve the training infrastructure and address skilled worker shortages
- assist the industry in adopting competitive practices and solutions where possible, such as COTS, not only for military and government markets, but also in dual-use civilian technology.

## 2 KEY POINTS ABOUT THIS INDUSTRY

The global A&D electronics industry is characterized by products and services for gathering, communicating, processing and displaying the information required to conduct various aerospace and defence operations or missions.

Within this broad scope is a diverse collection of products for both military and civil markets that include avionics (instruments that guide, navigate and provide communications for aircraft, spacecraft and missiles), communications and surveillance equipment (such as radar and sonar), and simulation and training systems. The industry also manufactures related electromechanical equipment (for example, space robotics, aircraft power management systems and environmental controls) and electro-optical equipment (for example, infrared night vision systems using thermal imaging technology).

**Military and civil  
markets are served**

Most of the A&D electronics manufacturing plants are classified in Statistics Canada's *Standard Industrial Classification* (SIC) 3359 ("Other Communication and Electronic Equipment Industries"). Additional establishments are found in SIC 3361 ("Electronic Computing and Peripheral Equipment Industry"), SIC 3911 ("Indicating, Recording and Controlling Instruments Industry") and SIC 3912 ("Other Instruments and Related Products Industry"). Because software, engineering and project management services comprise a significant proportion of industry activities, some establishments can be found in the services SICs, such as SIC 7752 ("Offices of Engineers") and SIC 7721 ("Computer Services").

**Industry data come  
from many sources**

The statistical data were obtained principally from the 1997 Industry Canada Aerospace and Defence-related Industries Survey. Statistical data concerning the aerospace and defence sector as a whole can be found on our web site (<http://strategis.ic.gc.ca/SSG/ad03279e.html>). Data concerning the aerospace and defence electronics subsector specifically were pulled from the main database, and are not available on this web site. To develop as complete a description of the industry as possible, the research for this *Overview and Prospects* also included data available from industry associations, trade publications and expert opinions of knowledgeable industry observers, which may differ from those from traditional sources such as Statistics Canada. As a result of differences in the industry definitions used by the various researchers, the assumptions they made and their method of data collection, there may be inconsistencies in some of the tabulations and conclusions reached. However, the directions of the trends reported are consistent.

## **2.1 Global Context**

### **Customers are demanding**

Entering and competing in world A&D electronics markets requires skills, technology and resources beyond the capacities of most other industries. Industry customers are sophisticated and demand rigorous quality, safety and performance standards. In addition, as they are relatively few in number, these purchasers exert considerable buying power. Government defence, space and air traffic management agencies are the primary end users of this equipment, along with airlines and telecommunications service providers. The prime manufacturers of aircraft, spacecraft and other defence-related “platforms” (such as armoured vehicles), into which these electronic systems and components are often incorporated, are also important intermediate customers.

Major firms in this industry have the capability to manufacture core proprietary subsystems and hardware components as well as the ability to write the proprietary software enabling the hardware components to function together as a system. A sizable — and growing — proportion of this work is services-related, as it involves activities such as customized software program writing, systems integration and testing, and project management. Supplier firms provide software or hardware components suitably modified for aerospace and defence applications (for example, ruggedized circuit boards).

### **Production is low volume**

A&D electronics is characterized by low-volume, customized production suited to the often unique mission requirements of individual customers. In many cases, production is more similar to commercial “market testing” or “prototype” production levels of other manufacturing industries. Even the “large” production levels (for example, levels found in commercial aircraft avionics) sometimes attained are far from typical commercial mass production levels. Limited production runs or “single unit” systems, for example, satellite payloads, restrict opportunities for economies of scale or learning curve cost-reduction effects. As a result, the industry has tended to lag other manufacturing industries in its application of new cost-reducing process techniques.

Historically, government military and space customers have emphasized superior performance and have driven the development of leading-edge A&D electronics technology, although this focus now is shifting to include economic considerations also. Through their large procurement budgets and their unique purchasing behaviour relative to commercial buyers, these customers have also imposed a set of business practices on aerospace and defence electronics companies that differ from conventional commercial business practices.

On the one hand, these practices have left a legacy of high-cost business processes (relative to commercial best practices) for many A&D electronics companies. Government customers have generated detailed and stringent production as well as performance specifications. These specifications have stipulated rigorous testing, extensive quality audits and copious amounts of reporting documentation (often referred to as "mil-spec") that have translated into high production overhead burdens. At the same time, government customers have demanded strict security measures and have driven long product development cycles with their attendant need for spares storage and logistical support, all of which have generated additional overhead costs. As well, bidding procedures for large government contracts have created high marketing costs that can run into the millions of dollars for companies submitting bids.

**Government procurement practices are a source of higher production overheads**

On the other hand, government customers (particularly in the U.S. and Europe, and to a lesser extent in Canada) traditionally have paid for a company's product development costs (referred to as "cost-plus" contracts). This practice has provided companies with a stable source of technology research and product development funding as well as revenues. Leading-edge electronics technology, paid for by a government customer, can readily lend itself to the development of products for sale in commercial aerospace markets. Opportunities exist as well for cross-sectoral technology spillovers where A&D electronics technologies spawn products in other industries (although increasingly the industry is using technologies developed by other industries, especially the commercial informatics industries).

**Government contracts have paid for technology development**

These practices are now changing, as more cost-sensitive government customers attempt to emulate the practices of commercial buyers (see Section 3: Changing Conditions and World Industry Response). The extent to which governments can emulate commercial procurement practices is still open to question. In the interim, government projects still generate additional overhead burdens and, at least for the major aerospace and defence corporations, pay for a significant proportion of R&D activity. As a consequence, for cost and security reasons, it is often the case (particularly in the U.S. and Europe) that companies either specialize in military production or separate their military and commercial manufacturing operations.

As a high-technology industry, A&D electronics offers economic benefits such as export revenues, technology spillovers to other industrial sectors, high-paying jobs and, most importantly, a technology-based competitive advantage to the national economy. Recognizing it is a sector in which defence requirements and industrial policies converge, the hand of government has been instrumental in the development of the international industry — especially through non-tariff barriers, such as public ownership, direct R&D support, government procurement practices that favour domestic industries and requirements for industrial benefits (offsets).

**Government intervention is significant**

Security imposes restrictions on some trade

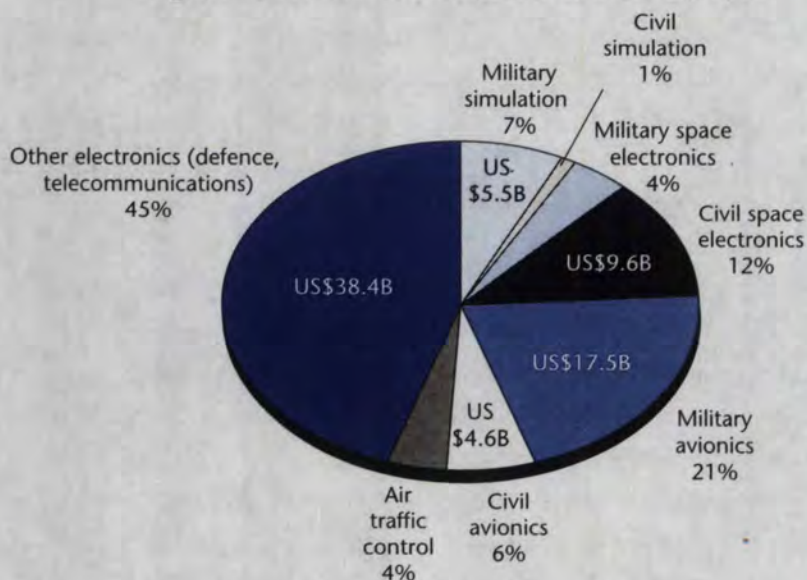
The desire by governments to maintain a strong domestic capability has led to a significant proportion of world trade in A&D electronics being managed through limited bilateral or multi-lateral government-to-government defence and space agreements. For example, Canada and the U.S. are partners in the Defence Development Sharing Arrangement (DDSA) and the Defence Production Sharing Agreement (DPSA). Although these agreements provide the Canadian industry with some access to restricted U.S. government research and procurement markets, Canadian companies may still face security and technology transfer restrictions. As well, exports to unstable or belligerent countries, or countries with poor human rights records, are subject to international agreement and/or domestic permit systems to control the export of defence electronics.

World sales fluctuate with government funding

Despite General Agreement on Tariffs and Trade (GATT) rules that eliminated tariff barriers between signatories on civil aircraft products (including civil avionics and flight simulators) and that restricted the discriminatory use of government procurement, many countries use national security exceptions to provide direct financial assistance to their domestic industry and to impose domestic content requirements on government procurement.

Worldwide sales of A&D electronics were approximately US\$83 billion in 1997 (Figure 1). Sales fluctuate with the levels of government defence, space and air traffic control program funding (determined by government budget levels, policy and political dynamics) and with conditions in commercial aerospace markets. Commercial avionics sales tend to be cyclically tied to air travel levels and new civil aircraft deliveries, although the constant requirement for aircraft system upgrades and maintenance to existing airline fleets tend to dampen swings in avionics demand.

**Figure 1. World A&D Electronics Market, 1997**



Estimated world market US\$83 billion

Source: Industry Canada analysis based on data collected from trade publications.



The United States, the United Kingdom, Germany and France, as home bases for the world's major aerospace and defence prime manufacturers, dominate the industry (Table 1). Through continuous and massive military and space investment over several decades, these countries have developed the most extensive and capable A&D electronics industries. Their large aerospace and defence corporations manufacture complete platform and weapons systems — aircraft, spacecraft, naval ships and military vehicles — including the electronics systems that enable these platforms to function.

**U.S. and European aerospace and defence conglomerates dominate**

**Table 1. Selected Major Aerospace and Defence Corporations**

Company (country)	Total aerospace and defence revenues, 1997	Share of aerospace and defence revenues related to electronics
	(US\$ millions)	(%)
Boeing Inc. (U.S.)	45 800	10
<i>Lockheed Martin</i> (U.S.)	28 000	52
<i>Raytheon</i> (U.S.)	13 700	50
Aérospatiale (France)	9 384	6
Daimler-Benz Aerospace AG (Germany)	8 537	31
<i>Thomson-CSF</i> (France)	6 423	100
<i>AlliedSignal Aerospace</i> (U.S.)	14 500	60
<i>GEC-Marconi</i> (U.K.)	18 388	100
Lagardère Group (France)	10 986	100
Honeywell, Inc. (U.S.)	8 030	100
Siemens AG (Germany)	59 000	100
CAE Electronics Inc. (Canada)	644	49

Note: Companies in italics have Canadian A&D electronics subsidiaries.  
 Source: Trade publications, company annual reports, Industry Canada analysis.

The United States, by far the largest purchaser and producer of both military and civil systems, has the greatest technological breadth and depth. Russia and Eastern Europe have advanced capabilities in defence electronics technologies; however, they have yet to develop fully competitive civil capabilities. While Japan excels in the consumer electronics industries, its presence has not been significant in capabilities associated with A&D electronics. The Japanese government, however, is being quite aggressive at developing a space electronics capability. As government customers focus more on commercial technologies and products, countries such as Japan may earn a more significant role in electronics for aerospace and defence applications.

**U.S. leads in production and purchasing**

## **2.2 North American Context**

Canada's industry is characterized by significant foreign ownership, with many companies being subsidiaries of large U.S. aerospace and defence corporations. Canadian-owned companies such as CAE Electronics and COM DEV are small in comparison with the U.S. aerospace and defence giants and do not enjoy a commensurate level of support from large domestic defence and space budgets. As a result, the range of design and manufacturing expertise as well as system integration capability in the Canadian industry is more limited. Given the small Canadian market, Canadian companies' successes have emanated from the international marketplace as manufacturers of small systems and subsystems for specialized niche markets.

**Cost constraints  
pose a major challenge  
for Canadian firms**

Changes in the A&D environment pose a challenge for Canada's industry. The escalated cost of A&D systems, combined in the early 1990s with reduced government budgets and the slowdown in the airline industry, has heightened customer cost sensitivities. In response, world industry consolidation has accelerated and has forced an increased emphasis on cost considerations as well as design and manufacturing efficiencies (in addition to technology performance). Canadian companies, particularly foreign-owned subsidiaries, now face more powerful competitors, customers and corporate parents who are restructuring, reducing capacity and streamlining their supplier base to achieve greater efficiencies.

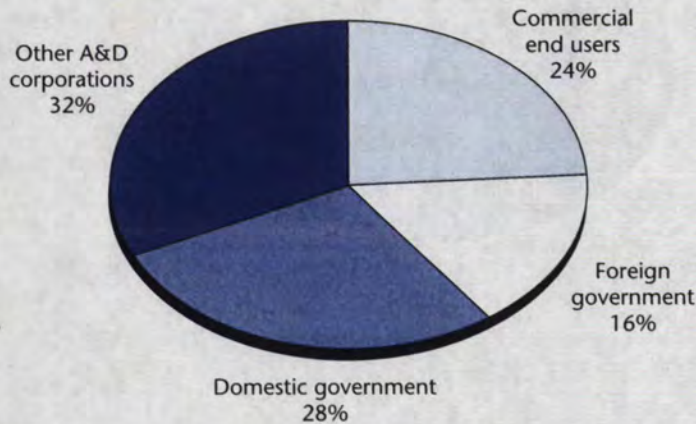
The U.S. aerospace and defence industry has responded to constrained government budgets and fewer procurement programs by accelerating its previous consolidation pace. Since 1990, more than US\$60 billion has been spent on merger and acquisition activities, with the U.S. government covering some of the costs as a means of encouraging industry rationalization.

### 2.3 Canadian Industry Snapshot

The Canadian A&D electronics industry is diversified in its product and market focus (Figure 2). Some 61 percent of industry sales in 1997 were to export markets, including 16 percent to foreign governments. Some firms, however, were quite dependent on sales to domestic government customers, who together accounted for 28 percent of industry sales in 1997. A further 32 percent of sales in 1997 went to other aerospace and defence corporations. Overall, Canadian A&D electronics sales in 1997 were about equally divided between commercial and military markets.

Markets are well diversified

**Figure 2. Customers of Canadian A&D Electronics by Proportion of Sales, 1997 (estimate)**



Source: Industry Canada Aerospace and Defence-related Industries Survey, 1997 (<http://strategis.ic.gc.ca/SSG/ad03279e.html>).

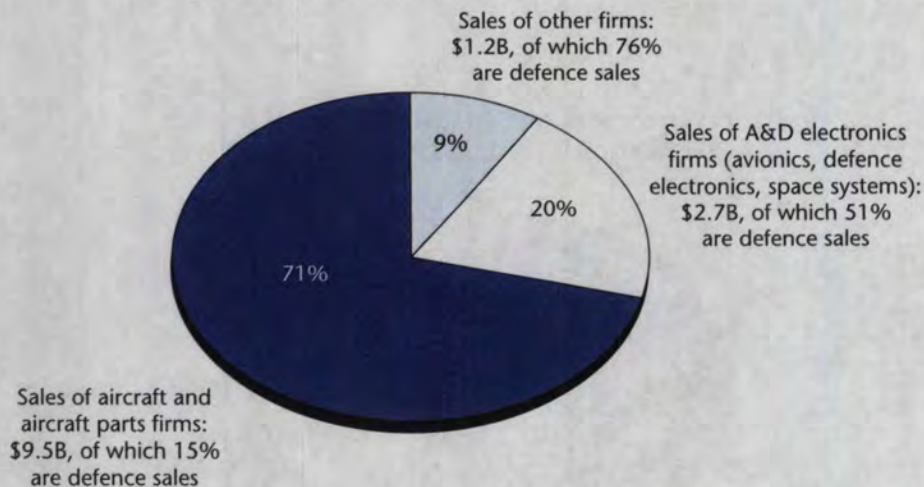
Canadian A&D electronics industry shipments include an impressive array of high technology, proprietary products that serve both civil and defence markets. These are products such as flight simulators by CAE Electronics, the space shuttle Canadarm by MacDonald, Dettwiler, the mobile satellite communication antennas by Canadian Marconi and CAL, and the communications, command and control systems, underwater surveillance and fire control systems of Computing Devices Canada. Table 2 provides examples of Canadian A&D electronics companies and provides an illustration of their product diversity.

Canadian firms specialize in wide range of components

In 1997, A&D electronics accounted for 20 percent of Canada's total aerospace and defence-related high technology sales (Figure 3).

**Figure 3. Canada's Aerospace and Defence-related Industries Sales, 1997**

**Total A&D sales, 1997 (estimated): \$13.4 billion**  
**Defence sales, 1997 (estimated): \$3.7 billion**



Source: Industry Canada Aerospace and Defence-related Industries Survey, 1997 (<http://strategis.ic.gc.ca/SSG/ad03279e.html>).

**Industry is concentrated in Quebec and Ontario**

The industry is highly concentrated. The eight largest firms (consisting of a dozen plants) generate close to 60 percent of total industry manufacturing shipments. Regionally, the industry is heavily concentrated in the provinces of Quebec and Ontario, with Quebec contributing about 40 percent of shipments, and Ontario about 50 percent. Important companies are also resident in other regions. In western Canada, for example, growth has been centred on companies such as Computing Devices Canada, Pelorus Navigation Systems, Raytheon Canada Limited, and MacDonald, Dettwiler and Associates Ltd. In Atlantic Canada, examples of companies are Hermes Electronics, KB Electronics, Litton Systems Canada in Halifax and COM DEV in Moncton.

Most major firms are members of the Aerospace Industries Association of Canada (AIAC). Others, with interest in military markets, are members of the Canadian Defence Industry Association (CDIA). In addition, provincial aerospace associations or councils in Newfoundland, Nova Scotia, Ontario, Manitoba, Alberta, British Columbia and Quebec operate to promote the interests of firms and to provide strategic guidance to the industry.

**Table 2. Company and Product Examples**

Company name	Product examples														
	Civil aircraft avionics	Military aircraft and missile avionics	Spacecraft and missile avionics	Space avionics	Space communications	Space science	Military command, control and communications	Air traffic control systems and radar	Other surveillance and detection	Simulation	Electronic warfare	Robotics	Electro-optics	Military land electronics (retronics)	Military shipboard electronics
<i>AlliedSignal Canada</i>	✓	✓	✓									✓			
CAE Electronics							✓	✓							
<i>Canadian Marconi</i>	✓	✓				✓									
COM DEV				✓											
<i>Computing Devices Canada</i>						✓	✓							✓	
<i>Litton Systems Canada</i>		✓												✓	
<i>Lockheed Martin Canada</i>								✓	✓						
<i>MacDonald, Dettwiler</i>				✓	✓	✓					✓				
<i>Oerlikon Canada</i>														✓	
<i>Raytheon Canada</i>							✓					✓			
SED Systems				✓										✓	
<i>Sextant Avionique</i>	✓														
<i>Thomson-CSF</i>														✓	✓
<i>EMS Technologies Canada</i>				✓	✓	✓		✓							

Note: Foreign-owned companies are in italics.

Source: Industry Canada analysis.

**Foreign ownership  
is significant**

The relatively high level of foreign ownership and control distinguishes the Canadian industry from its international counterparts in the U.S. and Europe. Although the major companies in this industry are predominantly subsidiaries of large foreign aerospace and defence conglomerates, many are small and wholly owned by Canadians. Approximately 40 percent of total industry revenues are earned by Canadian-owned companies, and 40 percent by U.S.-owned operations. In contrast, for the Canadian economy overall, *Corporations and Labour Unions Returns Act* Reports show that 70 percent of operating revenues are generated by Canadian-controlled corporations and only 20 percent by U.S.-controlled firms.

**Industry is powerful  
generator of jobs, GDP**

Foreign-owned companies feature varying degrees of autonomy or integration with their parents. The relationship ranges from companies that have a full world product mandate for products they design, market and support, to companies with mandates limited to the domestic government market and/or who are dependent on their parent for technology and marketing.

A&D electronics manufacturing is an industry in which value-added has consistently accounted for at least 60 percent of the total value of output. An analysis of Statistics Canada data indicates that the industry's sales are a strong generator of jobs and national income among Canada's high technology, knowledge-intensive industries.

**A&D electronics  
industry employs  
highly skilled,  
highly paid workers**

R&D, other high value service activities and precise manufacturing techniques characterize the design and production processes of this industry. The quality of its human resources is a critical element in the industry's competitiveness. The industry employs a significantly higher proportion of engineers and technicians who command higher remuneration than most other manufacturing industries.

**Benefits of  
technology extend  
to other sectors**

Due to the need for precision and reliability in A&D electronics technologies and products, and the potential of these to be widely applied outside the industry, several companies have demonstrated the benefits of their R&D efforts to other sectors in the Canadian economy.

Applications include intelligent transportation systems (ITS), robotics, electronic product labelling in retail stores, toll collection, home security systems and global positioning satellite (GPS) based navigation systems used by ships and truck and taxi fleets. AlliedSignal Canada is planning to adapt military night vision sensor technology to allow commercial travel on a future "smart" highway. Spar Aerospace's innovative work with space robotic systems is being utilized to develop robotics to improve the safe handling of hazardous materials.

Canadian-owned companies such as CAE Electronics and COM DEV are small in comparison to the U.S. and European aerospace and defence giants and do not enjoy a commensurate level of support from large domestic defence and space budgets. As a result, the range of design and manufacturing expertise, and system integration capability in the Canadian industry is more limited. Consequently, Canadian companies' success internationally has been as manufacturers of small systems and subsystems for specialized niche markets.

Canada does not manufacture large defence electronics systems, although there have been a few exceptions such as naval frigate systems for the Canadian Armed Forces. Hence, its defence sales consist primarily of subsystems or components. Canada does manufacture some missile guidance and weapons fire control equipment; however, its main strengths lie in its surveillance and detection capabilities. For example, as an outgrowth of Canada's anti-submarine warfare role within the North Atlantic Treaty Organization (NATO), a number of companies hold strong positions in the market for acoustic signal processing used in the detection of submarines and mines.

**Canada is most  
successful interna-  
tionally in specialized  
niche markets**

**Defence capabilities  
are focussed on  
surveillance and  
detection products**

## **2.4 Government Policy and Support**

### **Government support levels playing field**

Canada's industrial policy in the sector has actively promoted the development of a diversified, internationally competitive, private sector industry. At the same time, the policy has recognized the need to place Canada's industry on an equal footing with foreign competitors assisted by their respective home governments. The primary instruments are based on market access, government procurement and financial assistance.

### **Market Access**

In civil markets, Canadian policy has focussed on limiting or eliminating structural impediments to trade through endorsement of the Agreement on Trade in Civil Aircraft within GATT. Although the industry also makes use of the sales financing services of the Export Development Corporation (EDC), trade in defence and space products is governed more by bilateral country-to-country agreements. Such agreements include the DPSC and DDSA, which give Canadian companies limited access to U.S. military procurement markets and R&D programs, and agreements with foreign space agencies such as the National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA).

### **Government Procurement**

Government of Canada procurement has been used to lever domestic industrial development and to foster market access. Canadian Space Agency (CSA) purchases of space systems, Department of National Defence (DND) purchases of defence electronics systems and Nav Canada purchases of air traffic control equipment have enhanced the technological capabilities of the industry. By acting as a launch customer, the government has also helped to establish the credibility of Canadian products in international markets.

Industrial benefits (offsets) negotiated on major government purchases continue to facilitate the development of business relationships between domestic suppliers and foreign prime manufacturers, countering the domestic content and offset policies of other countries.



**Direct Investment**

Direct federal government financial support to the A&D electronics industry has been concentrated on R&D assistance. This is accomplished primarily through Technology Partnerships Canada (TPC), which takes a new investment approach to technology. A TPC investment is fully repayable, not a subsidy. The government shares with the private sector both the risks and the rewards of this investment, including a share of the proceeds. TPC works with established companies in specific segments of the economy, including aerospace and defence, to ensure that near-market projects result in products that actually reach the marketplace.

Canada's industry also has access to government-financed research facilities, although they are not as extensive as the government technology infrastructure of the U.S. and Europe. These facilities include the National Research Council's laboratories, the research establishments and programs of DND, Industry Canada's Communications Research Centre and the CSA.

### 3 CHANGING CONDITIONS AND WORLD INDUSTRY RESPONSE

**Customers are now  
more cost-sensitive**

Constrained by lower post-Cold War budgets, government buyers are taking more aggressive steps to contain the rising development and acquisition costs of major defence and space systems. The knowledge intensity and complexity of equipment has risen so dramatically since World War II that today few nations can afford to independently develop and procure a full range of defence and space systems. Where possible, government defence and space customers now search for cheaper solutions by adopting commercial procurement practices and purchasing commercial off-the-shelf equipment.

**Government  
customers avoid  
technology  
development costs**

An important feature of the COTS procurement strategy is that government defence and space customers are attempting, where possible, to avoid product development costs. One of the more effective ways to achieve this goal is to take advantage of rapid innovation in commercial computer hardware, software and telecommunications technologies, whose development costs have already been borne by the private sector. Furthermore, in their efforts to reduce costs, government buyers are allowing the substitution of previously developed commercial electronic components into defence, space and air traffic control systems contingent on the achievement of performance goals.

**Increased commercial  
competition challenges  
traditional A&D  
electronics suppliers**

Through these and other strategies, large customers such as the U.S. military aim to encourage production of military equipment at lower-cost commercial facilities. In this way, there is a reduced need to maintain a separate, unique and expensive defence electronics industrial base. As commercial electronics are deemed more acceptable for government defence and space applications, and as commercial information technologies increasingly offer solutions to military needs, traditional A&D electronics suppliers will face increased competition from commercial electronics suppliers who were unwilling, or unable, to sell into the government market in the past.

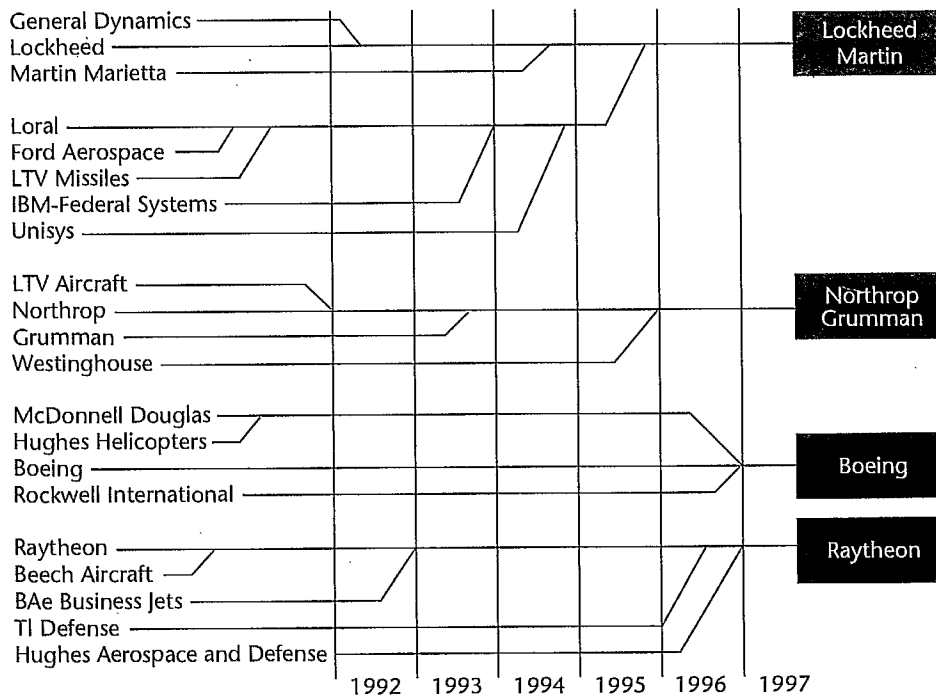
The extent to which the government purchaser can implement these cost-reduction strategies, however, remains unclear, and the process of change is incremental and slow. In some cases, for the military command, control and communications area, and in military simulation, much commercial research already exists, which lends itself well to the COTS strategy. Yet, many government defence and space requirements, particularly at the systems level (for example, a missile guidance system, weapons fire control system or satellite surveillance system), are unique and on the leading edge of technology. In these cases, the customer remains intimately involved in the development and production process (with the attendant additional costs) and in the financing of technology development.

Additionally, the A&D electronics industry is faced with commercial airline buyers who are more sensitive to the costs of new avionics equipment. Increased competition and more price-conscious travellers have strained airline profitability. Airlines are being forced to more closely examine the value of new avionics technologies and equipment, not only in relation to their acquisition costs, but also in relation to their maintenance costs and the extent to which they lower aircraft operating costs. This is extremely important, since the cost of acquiring a system frequently counts for only 50 percent of the total life cycle cost of an aircraft.

The U.S. aerospace and defence industry has responded to constrained government budgets and fewer procurement programs by accelerating its previous consolidation pace. As shown in Figure 4, since the early 1990s, these corporations have been going through an aggressive period of mergers and acquisitions unprecedented in its speed and scope. Since 1990, more than US\$60 billion has been spent on merger and acquisition activities, with the U.S. government covering some of the costs as a means of encouraging industry rationalization. While behind their U.S. competitors, the European aerospace and defence corporations are also moving in this direction.

Canadian companies face fewer, more powerful corporations as industry consolidation accelerates

**Figure 4. U.S. Industry Consolidation, 1992 to Present**



Source: Industry Canada analysis.

Consolidation strategies have mainly centred on the removal of excess design and manufacturing capacity and the capture of greater economies of scale and scope. More significant, from an A&D electronics industry perspective, have been the benefits of bringing together platform (e.g. airframe) technologies and electronic system technologies under one corporate umbrella. The restructuring of the industry has resulted in a rationalization of production, leading to greater efficiency and more horizontally and vertically integrated production.

In the U.S., most of the major independent space and defence electronic system suppliers have been absorbed into larger corporate conglomerates. For example, as shown in Figure 4, by acquiring the defence business of Rockwell, Boeing (traditionally focussed primarily on airframe manufacture) gained a significant presence in electronics. Similarly, Lockheed, another U.S. airframe manufacturer, joined with electronics corporations Martin Marietta and Loral Defence Systems to create a total system behemoth that now has annual revenues in excess of US\$28 billion:

Through diversification, corporations hope to spread risk across a wider portfolio of business. More significantly, they hope to increase their contract win rates by giving the customer a total systems solution that enhances final product performance while lowering design and manufacture cycle times.

**Supplier base is to be streamlined, take on greater technological and financial risk**

It is expected that consolidation at the prime manufacturer level will be followed by increasing pressure to streamline the aerospace and defence supplier base, including suppliers of avionics and other electronic systems and components. In the past, aerospace and defence prime or sub-system manufacturers often integrated components purchased separately from myriad different lower-tier vendors. This approach proved to be overhead-laden, time-consuming and costly. In response, prime manufacturers are reducing the number of suppliers with whom they will do business and insisting that these suppliers take on more of the responsibilities including the technological and financial risks of managing and greater scope for integrating whole system solutions.

**New design and manufacturing processes improve efficiency in industry**

The world A&D electronics industry is reacting to the competitive pressures of COTS and consolidation. Adoption of vital leading-edge design and manufacturing processes (the "soft technology") by A&D electronics companies has lagged other manufacturing industries and is uneven across the industry. Companies are now introducing new management techniques and manufacturing processes, such as total quality management (TQM), in an effort to gain an edge in their industry.

In particular, more efficient ways of managing and organizing work processes, particularly for white collar workers who contribute to an increasing share of activities, will be crucial as companies shed conventional manufacturing activities and move into higher level system integration and software activities. To avoid lower-cost commercial competition and to maintain a technological competitive advantage, many companies are increasingly focussed on the high-value project management, integration and testing work, while moving away from being manufacturing establishments to something more akin to an R&D laboratory or custom "system house." As part of this process, non-core competencies and simple manufacturing activities (for example, metal box fabrication or commercial standard electronics) are being outsourced to commercial suppliers who can provide these components and services at a lower cost.

Particularly as a result of constrained government budgets, heightened customer cost sensitivities have accelerated world industry consolidation and have forced an emphasis on production efficiencies. Canadian A&D electronics companies now face a more cost-competitive environment that is dominated by even larger foreign corporations, who in turn form more powerful competitors, customers and corporate parents.

**Firms try outsourcing  
to improve efficiency**

## 4 GROWTH PROSPECTS FOR THE INDUSTRY

### 4.1 World Market Outlook

After a decline in the early 1990s due to defence procurement budget reductions and a downturn in commercial avionics deliveries, world A&D electronics markets have stabilized and are recovering. The world A&D electronics market is expected to experience continued growth over the next decade in a number of areas linked to forecasted sales growth of fixed-wing and rotary aircraft as well as repair and overhaul (R&O), maintenance, retrofit and upgrade requirements. However, within certain mature areas of A&D electronics, market growth may begin to decline, followed by further industry consolidation.

A key driver of this stability, and of future growth, is the historical rise in the electronic content of aerospace and defence products. Budget constraints and the need for increased efficiencies and savings by cost-conscious civil and military customers — along with safety concerns and expanded, more complex missions — have increased the use of electronics in the aerospace and defence environment.

Electronic content  
of aerospace and  
defence products  
is rising

In the case of aircraft, for example, multifunctional displays, communication control panels, and related electronic systems and components have spread throughout the airframe, not only to improve performance and mission capabilities, but also to reduce acquisition and operating costs. Solid-state, modular electronics, and other innovations such as “fly-by-wire” and “fly-by-light” flight controls, are replacing some of the conventional components, thereby eliminating the huge amount of wiring, hydraulic hoses and steel cables found on previous generations of aircraft.

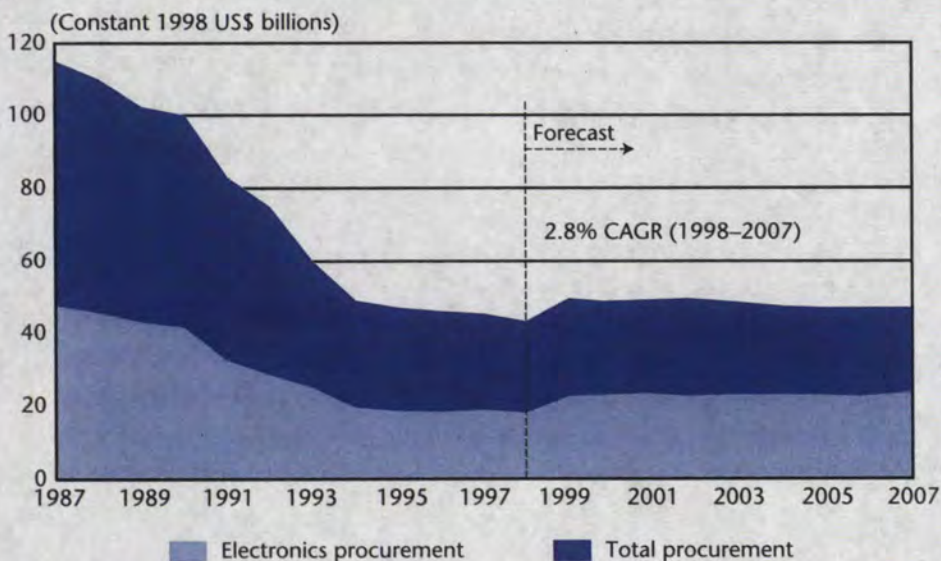
New avionics technologies such as flat, multifunction panel displays are more efficient and more easily replaced than previous equipment, thus increasing the life span of aircraft and reducing maintenance costs. Since these technologies will better manage, process and transmit flight information, aircraft will operate with fewer cockpit crew, fly on more direct routings and may experience fewer flight delays during adverse weather conditions. In addition, electronic maintenance monitoring systems are now increasingly used to oversee major systems such as engines and gearboxes to predict component failure, thereby augmenting safety and reducing aircraft downtime. Upgrades of existing, older aircraft fleets with these technologies can improve their efficiencies while postponing, where practical, the purchase of expensive, new aircraft.

It is projected that the cost of avionics and related electronics as a proportion of the total value of a civil airliner will more than double over the next ten years, from the present average of 10 percent of the aircraft purchase price, to more than 20 percent. Typically, this proportion for military aircraft is expected to rise from the present 39 percent of the purchase price to 45 percent or greater over the same time period. In the instance of the new state-of-the-art F-22 advanced fighter, estimates are that the value of the electronics will exceed 50 percent of the aircraft's purchase price.

**Future civil aircraft  
will contain twice  
as much electronics**

The trend has been for the electronic content of defence systems and operations to increase. This inclination, however, has been offset by deep cuts in procurement in the early 1990s, with the net result being only modest growth forecast for defence electronics markets. A return to procurement levels achieved during the heydays of 1980s defence expenditures is unlikely. The electronic content of the U.S. Department of Defense Procurement Budget, which accounts for a large proportion of world demand, is forecasted to grow on average by only 2.8 percent annually over the next ten years (Figure 5).

**Figure 5. U.S. Department of Defense Procurement Budget**



Source: Industry Canada estimates based on data from the Electronics Industries Association.

**Changed nature  
of warfare puts  
focus on smart  
electronic systems**

Despite only modest overall growth expectations, opportunities will be larger in certain segments of the defence electronics market as a result of greater strategic and tactical uncertainties and complexities for military mission planners. Well-defined Cold War threats to North America and Europe, based on a single ideology and more amenable to conventional heavy weapons (aircraft, missiles, ships, tanks) technologies, have been replaced by limited regional conflicts and clandestine terrorist activities. Fewer large weapons development programs and purchases are expected in the foreseeable future. Instead, there is now an increased emphasis in defence technologies on "smart" electronic systems used in intelligence gathering and communications, as well as the more precise delivery of ordnance with a minimum of civilian casualties.

To assist in this new warfare focus, existing military aircraft and missile types, for example, will be re-equipped with new modular electronic systems, where feasible, converting them into smarter weapons, surveillance and communications platforms, while simultaneously achieving savings in acquisition costs by extending their life expectancies. Unmanned aerial vehicles that utilize advanced electronic surveillance and communication systems to carry out missions, without incurring the expense and dangers of a pilot, are becoming a greater feature of military forces.

**Simulation offers  
a cost-effective  
alternative**

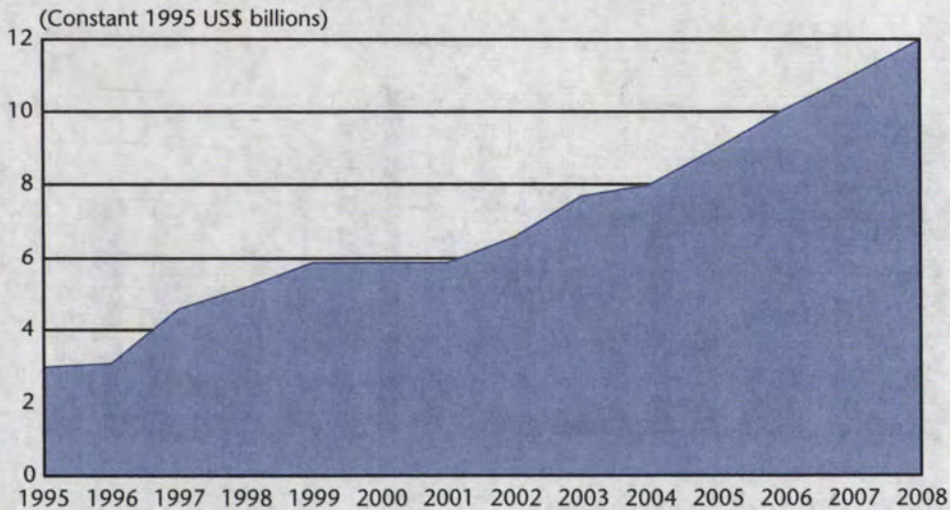
Expanded use of new electronics technologies, as a cost-reduction strategy, also extends to the use of simulation to test the effectiveness of new weapons systems and to provide safe and more affordable training. Rather than incurring the expense and danger of using flight time in actual aircraft to train aircrews or live fire exercises to train military personnel, training programs are now extensively based on the use of electronic simulation technologies.

**Commercial  
markets offer  
new opportunities;  
emerging regions  
offer fresh markets**

In contrast to defence markets, commercial aerospace electronics markets show more promising growth as a result of globalization. Increasing air travel and growth in civil aircraft sales, combined with the rising electronic content of civil aircraft, translate into a potential doubling of the world commercial aircraft avionics market (Figure 6). Simultaneously, the world's existing air traffic management infrastructure is coming under increasing strain.



**Figure 6. Commercial Aircraft Avionics  
Market Forecast, 1995–2008**



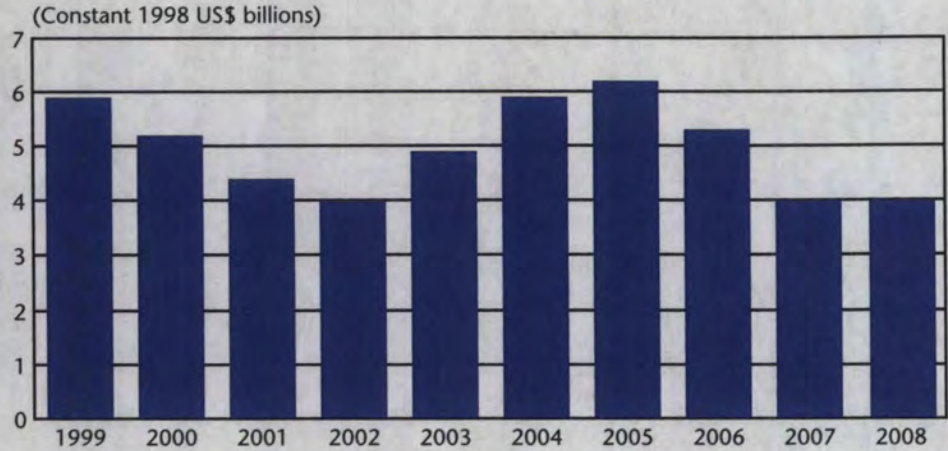
Source: Industry Canada analysis based on aircraft market outlooks from Boeing and Rolls-Royce.

U.S., Canadian and European air space management authorities have instituted major modernization projects to update aging air traffic control, communication and radar systems installed in the 1960s and 1970s. Also, should the Asia-Pacific and Latin American economies continue to expand, the resulting air travel growth will necessitate new and modern airport and air traffic management infrastructure.

Global deregulation of telecommunications and an increased need for mobile communications worldwide has created a very promising market for commercial space electronics in the form of satellite avionics, payloads and ground stations (Figure 7). In the past, satellite communications applications were restricted to long-distance telephone communications and video broadcasting by large television networks. A looser communications regulatory environment has created an explosion in consumer-oriented satellite applications, including direct-to-home satellite television, satellite personal communications systems and multimedia satellite systems.

**Expanding global  
communications  
spur commercial  
space applications**

**Figure 7. Commercial Communication Satellite Market Forecast, 1999-2008**



Source: Teal Group (<http://www.tealgroup.com/pressreleases/comsatforecast.htm>).

The use of wireless technology represents an enormous opportunity for the development of a higher-quality communications service at less cost than the wireline system. This is expected to result in significant growth in emerging nation markets, whose high demand and cost sensitivity are better resolved with a wireless infrastructure.

At the same time, advances in digital signal processing, microwave electronics production and satellite power capabilities have made these services technologically possible and affordable. As a consequence, production has achieved heightened volume levels, as constellations of new generation low and medium earth orbiting satellites are launched to create a globe straddling space communication network.

The segment breakdown of the commercial communication satellite market forecast is shown in Table 3.

**Table 3. Communication Satellite Market Forecast,  
Total Market Segment Breakout, 1999-2008**

Segment	Units launched	Value
		(1998 US\$ billions)
Mobile	449	8.2
Broadband/multimedia	384	17.7
Telecom/broadcast	102	12.5
Direct TV broadcast	82	11.4
Totals	1 017	49.8

Source: Teal Group (<http://www.tealgroup.com/pressreleases/comsatforecast.htm>).

## 4.2 Domestic Government Market Outlook

Customer cost sensitivities and expanded missions are increasing the role of electronics in aerospace and defence products and activities, creating opportunities for Canadian technologies and products. Commercial markets for avionics and space communications, both important to Canadian prospects, are expected to experience robust growth in the future. Overall, government electronics procurement budgets are expected to show only modest growth, with certain defence electronics market segments in which Canada has strengths (such as for simulation) faring better than others.

Canada's industry originated in Government of Canada defence, space, communications and air traffic control policies and procurement. This market, now smaller and more competitive, will offer Canadian industry fewer major projects and fewer opportunities for technology development.

Deficit reduction, deregulation and privatization measures, as well as the completion of a number of major capital purchases and the movement to COTS procurement practices, challenge an industry that has historically supplied 30 percent or more of its output to the domestic government.

**Robust growth in  
commercial markets  
is predicted**

**Military purchases  
are likely to remain  
below 1980s levels**

DND's capital procurement budget has been reduced as the department adjusts to fiscal restraint and the changed post-Cold War military environment. Developmental opportunities are further reduced by DND's drive to cut costs by purchasing equipment off the shelf rather than paying for the development of Canadian technology. On the upside, future DND capital acquisitions will consist of major projects stretched out over a longer period of time and a series of smaller projects, all mainly of an electronic nature (either new systems or upgrades). It is, however, unlikely that the department's capital spending will reach levels achieved in the 1980s.

Similarly, developmental opportunities will be limited by the completion of major air traffic control infrastructure projects by Transport Canada, as well as the privatization of Canadian air traffic control operations. Canadian content considerations will still be in effect, but Nav Canada, the new non-governmental organization responsible for air traffic control operations, is also expected to purchase COTS equipment in a more competitive manner.

The CSA has been important in the development of Canadian space electronics capabilities, especially in areas such as robotics, remote sensing, communications and scientific instruments. Most of the R&D for the Canadian space program is carried out by Canadian industry, thereby generating technology and product development in Canada. This role has recently been strengthened by the Government of Canada's provision of additional resources of \$430 million over the next three years, and thereafter stable funding for the CSA of \$300 million a year.

**Communications  
regulation  
becomes less  
restrictive**

At the same time, Canadian companies will face more competition to supply commercial satellite equipment to the domestic market now that Telesat is no longer a Crown corporation. Telesat, which had exhibited a strong Canadian preferential purchasing behaviour, will be losing its Canadian monopoly status as the supplier of space communications services by 2001.

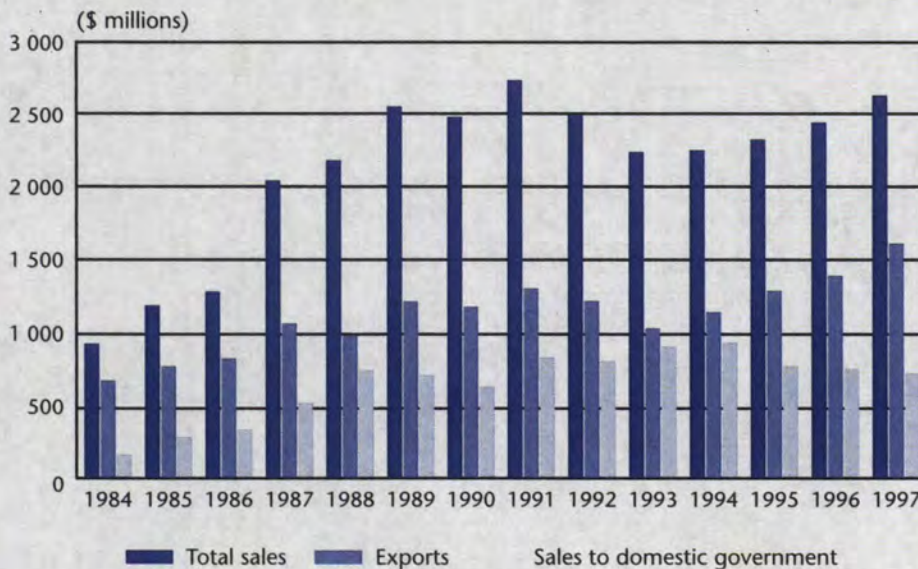
### 4.3 Canada's Competitive Position: Strengths, Weaknesses and Performance

A focus on dual-use niche technologies, a lowered dependence on shrunken government markets and improved productivity implies that the Canadian industry can position itself to take advantage of the growth trends in aerospace and defence markets and related non-traditional markets. Some Canadian companies, however, remain vulnerable to reduced government budgets, cost pressures and world industry consolidation.

As a result of industry consolidation and rationalization, heightened customer cost sensitivities and low government budgets, there are strong signs that Canada's industry is adjusting to changes among its competitors in the aerospace and defence marketplace and is poised for growth. In 1995 and 1996, sales began to recover (Figure 8) and in 1997 continued to approach their 1991 peak level. Importantly, this has been accompanied by an increased diversification of these sales away from the domestic government and defence markets and toward commercial and export markets.

Canada adjusts to change in aerospace and defence markets

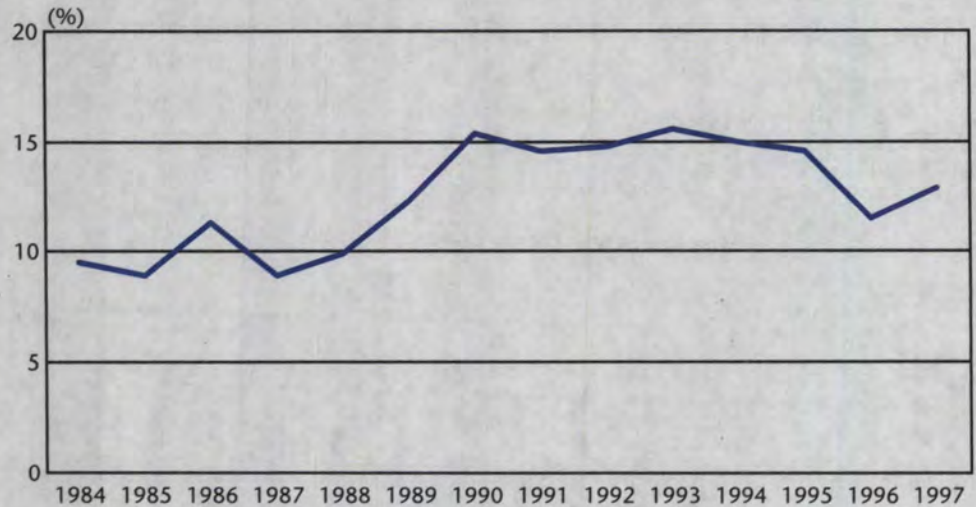
**Figure 8. A&D Electronics Industry Sales**



Source: Industry Canada Aerospace and Defence-related Industries Survey, 1997  
 (<http://strategis.ic.gc.ca/SSG/ad03279e.html>)

A number of factors underlay this adjustment and recovery. The industry has invested in an assortment of proprietary products well suited to the growth patterns emerging in A&D electronics markets. Examples of such products are simulators for both civil and military customers, commercial space communications equipment and commercial aircraft avionics. Concern, however, must be raised over the recent reduction in the R&D intensity of the industry. Since the early 1990s, the industry's investment in R&D has dropped from the equivalent of 14–15 percent of the value of total industry sales to 11.5 percent in 1996, rebounding to 12.9 percent in 1997 (Figure 9). This may be related to reductions in government R&D contributions and the winding down of major government procurement projects.

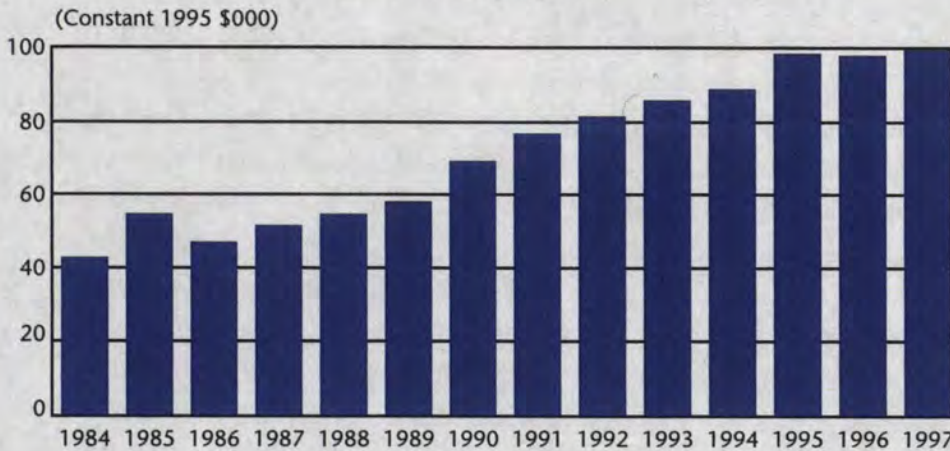
**Figure 9. A&D Electronics Industry R&D Intensity as a Share of Sales**



Source: Industry Canada Aerospace and Defence-related Industries Survey, 1997  
 (<http://strategis.ic.gc.ca/SSG/ad03279e.html>).

Adjustment has also been exhibited by a steady improvement in productivity. Real value-added per worker more than doubled between 1986 and 1997, growing from \$47 000 to \$100 000 in constant 1995 dollar terms (Figure 10).

**Figure 10. A&D Electronics Industry Real Value-Added Per Employee**



Source: Statistics Canada, Catalogue No. 62-011-XPB; and Industry Canada Aerospace and Defence-related Industries Survey, 1997 (<http://strategis.ic.gc.ca/SSG/ad03279e.html>).

This productivity gain may be partially attributed to the practice of new management and production methods, such as total quality management and best manufacturing practices, and improved design and production equipment such as computer-aided design/computer-aided manufacturing (CAD/CAM). As well, some Canadian companies have adjusted their operations to contract out lower-value-added activities such as metal parts fabrication, and have concentrated upon higher-value-added proprietary activities and systems integration.

Despite the availability of new opportunities and rising productivity (see Figure 10), the current shortage of highly skilled workers to design and produce A&D electronics may present an impediment to future growth. Structurally, the industry has experienced important adjustments in the skills and occupational composition of its work force. Engineers and other technical occupations now account for a greater proportion of the work force than in the past, primarily because CAM or robotics has reduced the non-high-skilled portion of the labour force to very low levels. Companies are seeking workers with a broader range of technical skills to perform more sophisticated assembly and testing of electronics equipment. There is concern that Canada's education and training systems need improvement in order to meet these needs and that Canadian remuneration is not competitive with that in other international jurisdictions in attracting and retaining the necessary skilled labour. In addition, to a great extent the industry competes with fast-growing commercial information technologies industries for skilled labour.

**Shortages of skilled workers may impede growth**

Canadian A&D electronics companies are major participants in regional groupings of aerospace companies that have tackled the skills shortages issue in a proactive way in partnership with educational institutions, governments and other stakeholders in the human resources field. In Ontario, the Aerospace Industry Training Program (AITP) was launched by the Ontario Aerospace Council in 1999. The initial phase of the AITP provides training curricula in two areas: aerospace manufacturing skills, and program and contracts management. In Quebec, the Centre d'adaptation de la main-d'œuvre aérospatiale au Québec (CAMAQ) for years has researched the existing and forecast human resources requirements of the industry and has worked with educators and government to fulfil these requirements. CAMAQ is the principal channel for providing industry input, for example, into the master's degree program in aerospace engineering in Quebec universities and a specialized trade school for training aerospace workers. Aerospace associations in Manitoba, Alberta and British Columbia have formed partnerships with a range of high schools, colleges and universities in their provinces to institute programs at various levels to equip students with the skills needed by the industry in western Canada.

Everywhere in Canada, A&D companies undertake significant formal and informal training to improve and expand the skills of their existing employees, in addition to assisting upcoming students through internships and other interaction with educational institutions.

**Some plants remain  
vulnerable and  
need to recognize  
challenges**

While in general the industry exhibits strong signs of adjustment, the ability to recognize and meet the challenges of consolidation, commercialization and process efficiency improvements varies among Canadian A&D electronics companies.

Most of the industry's revenues are generated by companies that are internationally competitive, with all or some of the following characteristics:

- dual (civil and military) use proprietary products
- strong, independent product mandates focussed on civil and defence export markets
- an ability to pursue alternative technology strategies, for example, by entering into strategic alliances when an individual effort proves too risky and costly or too limited to diversify its markets
- a first or second place position in terms of the world market share for their core product technologies.



For some of these companies, the domestic government market still accounts for a significant share of their sales and they may need to increase their presence in civil, non-government and/or export markets.

Some foreign-owned subsidiaries, however, are more vulnerable when they:

- are heavily reliant on domestic government procurement, which is now diminished from former levels
- have limited finance, technology and marketing autonomy from the parent corporation
- lack strong proprietary product technology, although they may have readily available system integration and software services
- lack a broad, strategic vision for being internationally competitive, after a historical mandate to serve the domestic defence market
- continue to have an overhead-laden, cost-plus manufacturing culture and are less likely to have adopted innovative commercial best practices.

The difficulties of these companies are magnified by a weak position within a large foreign-owned aerospace and defence corporation that is restructuring and rationalizing its operations.

#### **4.4 The Bottom Line**

The A&D electronics market has not enjoyed strong growth, but the productivity and competitiveness of Canadian producers has clearly improved. Canada is in a position to capitalize on the growth trends in which new technology and marketplace realities are moving this sector. The future growth of the Canadian A&D electronics industry will depend upon the following factors.

- The ability of Canadian companies to respond to the heightened stakes of accelerated world industry consolidation: As the major aerospace and defence corporations restructure and consolidate, Canada's aerospace and defence electronics industry and government must ensure that Canadian operations remain attractive developers and manufacturers of needed products. Foreign-owned subsidiaries must focus on improved production efficiencies and show their worth as strategic corporate assets for the medium- and long-term future or they risk loss of product mandates to other operations. Creating long-term, stable business relationships with the foreign prime manufacturers that are expected to survive consolidation will be crucial.

- The difficulties of Canadian companies in finding enough skilled workers: Many of the companies in this industry are challenged by shortages of critical skilled human resources. Production work now demands more technical knowledge and requires a multifaceted work force. Complex hardware integration engineering and software program skills in particular are in short supply, and this shortage is further exacerbated by more favourable remuneration in Europe and the U.S., with the latter having a lower tax burden. Companies will have to address the remuneration gap between Canada and other jurisdictions.

Technology is changing fast in aerospace, and the industry's skill requirements need continuous refinement and update. To deal with this challenge, some excellent initiatives and partnerships have been launched by individual Canadian A&D electronics companies, their industry associations and academic institutions. Governments have programs and initiatives that are supportive of these attempts to develop a science and technology-oriented culture in the industry and grow the next generation of post-secondary graduates who are qualified to meet the high skill demands of aerospace companies in the future.

- The need for government to level the international playing field, especially for R&D: Given the close relationship between governments, defence and space industrial policies and corporate activity in the international industry, Government of Canada programs will need to continue to level the international playing field to maintain Canada as an attractive location for investment. Unlike the host countries of its major aerospace and defence competitors, Canada does not have large defence and space budgets with which to support companies' technology and product development. Measures such as R&D tax credits and direct support through Technology Partnerships Canada (TPC) will continue to be needed, as will the maintenance of the government's research facilities.

Focussed intelligence and presence at high-profile activities, as well as sales financing options through the EDC, are some areas where the Government of Canada assists companies. The Canadian International Business Strategy (CIBS) conducts these types of activities to discover and augment trade opportunities.

Strategic exploitation of technology development opportunities resident in industrial benefits (offsets) on government procurement can also assist the industry. These should also capture investments that build on the strengths of Canadian operations and, along with government-to-government defence and space agreements, provide access to protected foreign government markets.

- **Adjustment to the changed nature of the domestic government market:** The domestic government market presents fewer business opportunities and is now more competitive as a result of tight budgets, privatization and deregulation. Fewer large domestic defence, space and air traffic control programs are expected in the future. A series of smaller electronics-related projects will make up the largest proportion of future government capital equipment requirements. Increased use of COTS and alternate service delivery practices will limit technology development opportunities and reduce the scope and application of industrial benefits. Companies dependent on this market may need to replace lost domestic business with civil and defence export business.
- **The pursuit of appropriate commercial market and export diversification strategies:** Despite the pursuit of prospects in non-traditional commercial and export electronics markets, it is important that companies stay focussed on their core technological specializations and pursue markets that fit these competencies. As foreign defence budgets remain large and as these budgets can be sources of funds for strategic technology development, complete withdrawal from the defence market is neither practical nor desirable for some companies. As Canadian companies are small in size and lack large total systems capabilities, the development of alliances with foreign companies could prove to be important. For some segments (for example, air traffic control), government sales financing can provide the edge over similarly assisted competitors.
- **The need to improve design and manufacturing efficiencies:** The movement of customers to commercial procurement practices, increased demands for cost and delivery time reductions, and more rapid product cycles require that Canadian companies develop and adopt leading-edge design and manufacturing processes. In particular, as companies shed conventional manufacturing activities and become component integrators and providers of software services, the implementation of more efficient white collar work processes will become a major focus. Government can assist by ensuring that defence and space procurement practices encourage companies to utilize best commercial design and manufacturing practices where appropriate.

- Responding to the challenge of lower-cost, commercial off-the-shelf information technologies: The rising trend in the commercial culture of cost control, subsequent customer demands for COTS solutions as much as possible, and the rapid entry of new commercial information technologies into aerospace and defence markets have increased competitive pressures on traditional A&D electronics makers. Barriers to entry (including military customer requirements) for commercial hardware and commercial software have been eroded in a number of aerospace and defence applications. Where possible, A&D electronics makers will have to take advantage of lower-cost commercial component inputs and/or keep moving into those activities and product areas (for example, customized systems integration or more complex customized software tasks) where their technological capabilities are competitive and unique.

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