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SUPPORTING DOCUMENT 2

# Profile of the **Aerospace Sector**

Prepared for the Expert Panel on Skills
by Dan O'Hagan and Laval Lavallée

1999

Canada

# PROFILE OF
# THE AEROSPACE SECTOR

Advisory Council on Science and Technology
Expert Panel on Skills

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## Abstract

Strong growth in the 1990s has made Canada a world leader in certain aerospace market segments, including strong positions in regional aircraft, large business jets, small turbines, helicopters and landing gear. Over the past five years, sales growth for the Canadian industry has been higher than that for any other country. Employment growth in the 1990s has also been strong. All market segments are expected to grow significantly in the next few years. The industry's success is related to its rapid adjustment to global realignment, its reorientation toward civil and commercial markets, and its innovations in design and technology.

Continued success of major Canadian aerospace companies will depend on their ability to bring new design and technology to market, which depends on the scale of research and development in the industry.

The ability of Canadian suppliers to compete for Canadian and other business will depend on acceptance of the design and technological risks associated with the new relationships emerging in the global industry. The ability to accept the financial risks of large, complex projects will be a major issue and may drive more consolidation and mergers. These merged companies will compete on production efficiency, ability to participate financially in large complex projects, and ability to innovate in design and technology rather than simply to build to specifications supplied by the assembly companies and large systems integrators.

This structural transformation in the industry, as well as other factors, drive a series of skill needs. These include design and computer-related skills, and high levels of engineering, technical and managerial skills. Industry surveys suggest that although the ability of Canadian educational and training institutions to turn out highly skilled scientific, design and research personnel will be an important issue, the ability to meet needs in the skilled trades will also be important. In addition, the industry's success will be related to its ability to attract, retain and upgrade its experienced workers.

# Contents

# INDUSTRY SECTOR CHARACTERISTICS

## The Challenge of the Future

### Economic and Market Pressures

Globalization, consolidation and rationalization will continue to drive the industry. The end of the Cold War has forced the industry to change focus from military equipment and cost-plus contracting to civil and commercial clients. The result has been more intense competition in the civilian markets where Canadian companies are the most active.

Both Boeing and Airbus, the leading producers of commercial aircraft, have recently forecast world growth in the aircraft industry of roughly 5 percent per year for the next 20 years. If these forecasts are correct, it would mean strong demand for products manufactured by the Canadian industry, such as commuter and regional aircraft, helicopters, and gas turbine engines.[1]

By extension, demand for related parts, sub-systems and services will be stimulated. In the short term, however, restructuring and consolidation in the airline industry has reduced the number of buyers and forced producers at all levels to cut prices drastically.

### Regulatory Situation

A number of regulatory and market access issues affect the industry, including the lack of harmonization of standards around the world in such areas as air worthiness and environmental standards.

The industry is also affected by local buying preferences in many countries, by government involvement in the purchasing process for many large clients such as national airlines, and by government involvement in the subsidizing of research and development (R&D).

The industry is being forced to switch to alternative materials and processes by environmental pressures and international conventions. The need to reduce greenhouse gases has forced a series

[1] Both companies forecast that the world commercial aircraft fleet will more than double over the next 20 years, with a demand over that period for between 16 000 and 17 000 new aircraft. The world market for new commercial aircraft, according to Boeing estimates, is some US$520 billion in 1997 dollars over the next 10 years and US$1.25 trillion in 1997 dollars over the next 20 years. Both of these estimates include only a portion of the smaller commuter plane market (15 to 90 seats), which Bombardier estimates to be worth roughly US$110 billion to the year 2015.

of technological changes in both airplane and engine design. These changes require both process and product changes in the supplier community.

### Technological Situation

Cost-related changes in technologies and work processes are changing the aerospace industry work force as the industry moves toward greater capital intensity. The industry already has one of the highest average education levels in the manufacturing sector, and the percentage of highly skilled scientific, design and engineering personnel is likely to increase while traditional machining and fabricating jobs decline in importance. Those fabrication jobs that remain are also changing with the introduction of new systems requiring flexible work arrangements and multi-skilling.

The increased technological sophistication required from second-tier suppliers will eventually be passed on to third-tier suppliers, and require significant new investment in technology, design capabilities and processes.

### Social and Demographic Situation

The industry has identified two kinds of human resource shortages affecting its growth: shortages of skilled workers, and shortages of experienced workers. The supply of both of these is affected by the cyclical nature of the industry that results in periodic crises of downside or upside adjustment.

Building the sector's image among young people as a good place to work has been targeted as a priority for the industry. Companies and schools surveyed for a recent human resource study of this industry reported that the blue-collar image of the industry may limit its attraction for young workers.[2] The cyclical nature of the industry, and highly publicized layoffs may have a similar effect.

## Current Situation

### Definition of the Industry

[2] Industry Canada, *Assessment of the Skills and Training Situation in the Canadian Aerospace Industry*, 1999. This image problem may be less serious than it was. An interview with the director of CAMAQ for the present study indicated that this is not an issue in the Quebec industry, and that all aerospace programs in the province are currently fully subscribed.

For the purposes of this study, the aerospace industry is defined as companies that engage in the integrated design, development, manufacture and marketing of complete aircraft and propulsion systems (usually referred to as primes); companies that specialize in the manufacture of major aircraft components such as navigation and communications systems, avionics, and aircraft sub-assemblies such as wings, fuselage components, flight controls and landing gear (referred to as second-tier firms); and subcontractors who supply goods and services to the manufacturers of aircraft parts and components (referred to as third-tier firms).[3]

In addition to aircraft-related production, some firms are also involved in space technologies, including the development of space station components, and communications and observations satellites. In terms of value, the space-related sector of this industry is small in relation to the aircraft-related production. Figures from the Aerospace Industries Association of Canada (AIAC) indicate that total sales of the space sub-sector were between $400 million and $500 million in 1997, with similar sales in 1998. This represents about 3 percent of total sales in the sector.[4]

The aerospace sector as defined here also includes a defence component, although not all defence-related industries are in the aerospace sector. As the most recent AIAC annual report notes, "civil products dominate Canadian aerospace sector output." Defence sales, mostly defence electronics, amounted to roughly 10 percent of aerospace industry sales in 1997 and 1998, but are growing more slowly than the larger sectors (such as airframe and propulsion) that dominate this sector. A significant proportion of defence-related sales are conducted by companies also active in civil and commercial markets.[5]

The aircraft maintenance and service sector is not directly included in this profile. However, the aerospace sector, as defined in this study, does include companies engaged in repair and overhaul (often major companies engaged in manufacture and assembly), and some of the comments about skills-related issues refer to people in these occupations as well as manufacturing trades and

[3] As the AIAC notes, this traditional three-tiered structure of the industry may be changing, as the large assemblers attempt to simplify their procurement programs by cutting down the number of suppliers with whom they deal directly. The trend to purchase entire systems and sub-systems from a smaller number of integrators is resulting in a four-tier configuration: the large assemblers, sometimes referred to as primes or OEMs (original equipment makers); the systems integrators who may supply parts and integrate parts from other suppliers; suppliers of sub-systems, some of which may come from the system integrators themselves; and smaller component and parts suppliers.

[4] Companies involved in space-related production include Spar (Canadarm for space shuttle and robotics for international space station), Canadian Marconi (Satcom antenna), MacDonald Dettweiler (earth observation satellite), and COM DEV (microwave beam link equipment for satellites). Source: *AIAC Annual Report,* 1998.

[5] AIAC, *AIAC Annual Report*, 1998. AIAC, *Canada's Aerospace Industry*, 1997 in Review.

occupations.[6]

The world aircraft industry is highly concentrated, with the Airbus consortium accounting for about 30 percent of the world market for commercial airliners and Boeing, about 70 percent. In Canada, more than four fifths of the industry's shipments are accounted for by a handful of primes and systems integrators. The remainder of the industry is divided up among roughly 1000 small and medium-sized enterprises (SMEs).

**Major Products and Markets**

Canada is active in world markets for commuter aircraft, business aircraft, helicopters, flight simulators and advanced gas turbine engines. Several second- and third-tier firms supply Boeing and Airbus with components.

Among the world markets served by companies operating in Canada, the following can be noted.[7]

- Bell Helicopter now accounts for 50 percent of the civilian helicopter market.
- Canadair Challenger (Bombardier) supplies 35 percent of the large business jet market.
- Pratt and Whitney Canada holds 33 percent of the small gas-turbine market.
- de Havilland (Bombardier) holds 20 percent of the market for 20- to 70-seat turboprop aircraft.
- Menasco, Messier-Dowty and Heroux collectively hold 20 percent of the global market for landing gear and 60 percent of the market for new large-aircraft landing gear.
- Canadian companies design and deliver more advanced simulator and training systems than any other country. CAE Electronics Ltd. is the world leader in the design and production of military and commercial full flight simulators and flight training devices.
- The repair and overhaul sector of the industry has developed extensive markets in environmental systems, avionics and communications systems, transmissions and constant speed drives.

[6] Maintenance and service involve routine maintenance, servicing and some repairs of functioning aircraft. The repair and overhaul sector of the aerospace industry includes repair and overhaul of major systems components, including engines, avionics, communications systems, transmissions and structures, and which also includes conversions, modifications and upgrades, updating and certifying equipment, and in some cases the machining and manufacture of complete systems and sub-systems as well as parts. Both service and maintenance on the one hand and repair and overhaul on the other use skilled trades and trained technicians such as aircraft maintenance engineers, who are trained and upgraded in Canadian community colleges and universities, and there is significant movement between the two sectors.

[7] AIAC, *AIAC Guide to Canada's Aerospace Industry,* 1998.

- The space sector markets advanced space communications systems and space robotics technology, primarily to U.S. clients.

The United States is the largest market for most of these products, taking about three quarters of the output of the Canadian industry.

## Production and Sales

According to the AIAC, global aerospace industry sales in 1997 were US$235 billion in constant 1997 dollars. With sales of $13.4 billion in 1997, Canada has the fifth largest aerospace industry in the world. Canada's aerospace sales have been growing faster than those of any other country over the past five years. Roughly 80 percent of Canadian aerospace sales are exported.

AIAC estimates for 1998 shipments are in the order of $15.3 billion. Between 1993 and 1997, shipments increased by roughly 50 percent.

While exports, and the relative importance of exports, have been growing, the Canadian value-added component of complete systems (the proportion of the total sales of complete systems that is made up of Canadian products or services) has been shrinking. In 1995, the Canadian value-added component of Canadian aerospace output was 66 percent of sales, but ran at only 54 percent in 1998.[8]

Table 1: Key Aerospace Statistics

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|
| Aerospace sales | 8.7 | 9.8 | 10.7 | 12.5 | 13.4 | 15.3 |
| Exports to U.S. market | 3.4 | 3.6 | 3.8 | 4.7 | 5.7 | 7.2 |
| Exports to rest of world | 2.5 | 3.3 | 3.4 | 3.9 | 3.8 | 4.8 |

Source: Aerospace Industries Association of Canada, *Canada's Aerospace Industry: 1997 Review.* (revised figures). All figures in C$ billions. Figures for 1998 are AIAC estimates.

### Geographic Distribution

About one third (35 percent) of the roughly 1000 establishments in this industry are in Ontario,

[8] Since 1993, the value of inputs from Canadian suppliers of services and products has grown 43 percent, that of U.S. suppliers, 51 percent and that of other foreign sources, 285 percent. Source: AIAC, *Speaking Out*, November 1998.

about 36 percent in Quebec and about 7 percent in British Columbia, with a smaller amount in Manitoba and Nova Scotia. Nearly all the largest companies are in Ontario and Quebec.

Quebec accounted for about 51 percent of aerospace revenues in 1997, and Ontario was second with 38 percent. The aerospace sector in the other provinces is smaller, but is still significant for local and regional economies. The aircraft parts and shipments industry is the most important manufacturing sector in Manitoba; it is the third most important [illegible] Scotia, and is a significant industry in British Columbia. Companies such as St[illegible] and Bristol Aerospace, active in the repair and overhaul side of this sector, [illegible]ant players in Western Canada's economy.[9]

**Relationships in the Industry**

Cost-related rationalizations have reduced the number of major companies in the industry as well as the industry's production capacity. The Boeing/McDonnell Douglas merger, for example, resulted in significant reductions in production facilities and employment in Canada and elsewhere. This process of reduction may continue for some time, since worldwide there is still considerable over-capacity in the civilian aircraft production industry.

The industry is globally oriented because the up-front investment required to develop, produce and market new products is too large to be amortized without long runs — which cannot be sustained by most national markets. Therefore, most first-tier companies draw their suppliers internationally, rather than from their home market, for both cost and political reasons. Second- and third-tier suppliers that represent most of the Canadian industry, must compete internationally to survive.

Cost-related considerations have forced the large aerospace companies (primes) to rethink their relationships with their major suppliers (second-tier suppliers of complete sub-systems). These companies in turn have begun to rethink their relationships with third-tier suppliers (producers of single components), which predominate in Canada.

These changes in relationships force Canadian companies to compete, on the basis of cost and timely delivery, against foreign companies, as well as to build new relationships with clients in parts of the world where they have not traditionally done business. Canadian companies with dated capabilities or the inability to innovate will be vulnerable as competitive pressures from suppliers in Asia and Eastern Europe intensify.

[9] The Prairies as a whole accounted for 8 percent of aerospace sales, the Atlantic accounted for 2 percent and British Columbia for 3 percent.

## Research and Development

Rates of R&D in this industry are higher than for industry as a whole. The aerospace industry accounted for roughly 14 percent of all R&D expenditures by Canadian industry in 1997.

## Unions and Professional Associations

The Canadian aerospace industry as a whole is highly unionized, with most estimates placing the overall rate of unionization in the industry at roughly 50 percent. Canadian Auto Workers (CAW) is the largest single union, with about 12 000 members in the aerospace industry, of whom about 10 000 work in the first-tier assembly part of the industry.

Other unions with representation in the industry include the International Association of Machinists (IAM), the *Fédération de la Métallurgie*, affiliated with the *Confédération des syndicats nationaux* (CSN) (11 percent), and the United Steelworkers of America — Canada (11 percent).

Major industry associations include the following:

- the AIAC, which represents companies in both the manufacturing and service sectors of the industry;
- the Canadian Aviation Maintenance Council (CAMC), a sectoral human resource council with representatives of both industry and labour; and
- the Canadian Defence Industries Association (CDIA), which represents companies in the defence and military equipment field, both aerospace and non-aerospace.

# MANAGEMENT PRACTICES

## Employment

Quebec accounts for almost half of the industry's employment and Ontario, for a little more than one third. The Prairie provinces have about 9 percent of total industry employment, the Atlantic provinces, 3 percent, and British Columbia, 2 percent.

Table 2: Aerospace Employment

| | 1993 | 1997 | 1998 |
|---|---|---|---|
| Total Employment | 54 000 | 64 000 | 67 000 |
| Source: Aerospace Industries Association of Canada, *Canada's Aerospace Industry: 1997 Review* (revised figures). Figures for 1998 are AIAC estimates. | | | |

## Skills and Training

On average, the aircraft and aircraft parts industry work force is more highly educated and earns higher incomes than the labour force in general. Sixty percent have a post-secondary education or diploma, compared with 45 percent in the general work force. Industry Canada's most recent statistical survey found the rate of post-secondary education at 47 percent, including those with certification in the apprenticed trades. Because a variety of smaller firms were included, the survey findings suggest that the ratio of skilled personnel to production personnel in the smaller (SME) section of the industry is probably lower.

Industry Canada's most recent surveys (summer 1998) of companies in the industry indicate that 21 to 22 percent of the work force in this industry (up from roughly 18 percent in 1990) are engineers and engineering personnel such as engineer technologists and design engineers, 60 percent (up from 56 percent) are production personnel and 18 percent or the work force (down from 26 percent) are employed in other types of work (e.g. secretarial, support staff, maintenance, management and sales).

Engineering employment in the sector had been increasing at roughly 5 percent per year through the mid-1990s, while the production work force had not been growing as quickly. In fact, recent consolidations have resulted in large layoffs of production staff. Total employment in most skilled trades has also been flat for the past several years. However, total employment figures are not a particularly useful measure of the demand for skilled and technical trades in this industry,

since there is strong demand for personnel with two to five years of experience, as opposed to entry-level candidates.

The production work force, mostly fabricating and machining workers, who make up about 60 percent of the work force, fall into four specific occupation categories: aircraft fabricating and assembling; machinists, aircraft mechanics, and repair and overhaul; fabrication inspecting; and other. These workers produce, assemble, and repair and overhaul metal aircraft components and mechanical systems to tight specifications and tolerances.

Generally, these skilled jobs require post-secondary education, apprenticeship in some cases, and some formal job-related training in all cases. This formal training is usually provided in-house and may be specific to the company or project. Thus, many of the production workers in this industry, while highly skilled and extensively trained, may not have portable skills that could be taken to other companies in the industry.

## Labour Relations

Since the industry is highly unionized, wages for most of the work force are determined through collective bargaining. Aerospace is a relatively high-wage employer, with average production wages roughly 25 percent higher than for manufacturing as a whole, according to AIAC surveys. CAW research and AIAC member surveys indicate that average production wages and salaries in the industry are currently about $48 000.

Collective bargaining and the state of labour management relations have been identified by industry representatives (at the skills dinner and in the literature) as a concern. Representatives at the dinner noted that there are few forums outside the collective bargaining system to deal with issues that may cause conflict.

## Other Issues

A major characteristic of the aerospace industry is the fact that it is program- and project-oriented, with teams assembled for specific purposes and then disbanded at the end of the project. This mode of production creates adjustment problems in the industry and makes it difficult for workers who are used to more traditional work styles to adapt to work in this industry. It also means that project personnel often need team and soft skills that are not always necessary in more common production environments. A lack of attention to these skills in training programs has been identified as a problem by various surveys.

While traditionally labour-intensive, the industry is becoming more capital-intensive, and there is widespread experimentation with new work processes and new technologies. This may have an impact on the industry's overall employment levels, as productivity levels increase. The industry's experience with new forms of work organization is more recent than, for example, that of the auto industry. Thus, the ultimate impact on the industry is not yet clear.

Interviews with industry officials suggest that critical skill shortages in design and technology are recognized as important issues among smaller companies, especially third-tier suppliers, and among some second-tier suppliers whose clients are exclusively within Canada. Because the aerospace industry is globalized, smaller suppliers must bid against similar companies in other countries, and may lose contracts because of their inability to supply parts of sufficient quality.

Skill shortages represent only one of many issues affecting Canadian suppliers. Since the large first-tier companies are increasingly forcing their suppliers to share the market and other financial risks associated with new aerospace platforms, access to capital is also an important issue. Marketing issues, including the problems of bidding against suppliers in other countries who may have government support or enjoy preference in some projects, are also significant.

# CRITICAL SKILL NEEDS AND GAPS

## Skill Needs

According to a 1997 survey undertaken by the AIAC, the availability of skilled and experienced workers is the top issue facing the industry, with shortages of skilled trades and production personnel, and people with advanced and specialized training.

Major commercial airplane manufacturers, such as Boeing and Airbus, forecast steady growth in regional and commuter airplanes over the next decade. Industry officials suggest that shortages in a series of maintenance and repair-related skills may emerge over the next several years. The manufacturing sector (repair and overhaul of complete systems, upgrades, updating and certification) competes for a number of these skills with the maintenance and repair sector. Shortages may therefore occur in the maintenance and repair sector, rather than in the repair and overhaul sub-sector of manufacturing, as the sectors bid against each other for experienced workers.

The fact that the industry is highly cyclical and oriented to specific projects rather than continuous production lines means that the industry experiences periodic adjustment crises, both upside and downside. This cyclical factor creates an image of instability that makes recruitment more difficult. The retention of experienced workers through adjustment cycles is also identified as a serious problem that results in shortages of middle-level skilled personnel.

The recent rapid increase in commercial aircraft production, especially in the United States, has resulted in widespread poaching and a serious "brain drain" problem. Aside from economic issues, many experienced workers are drawn to the United States because of a general perception of more challenging work and the ability to work on more advanced projects.[10]

The industry has a long tradition of recruiting skilled and experienced workers from abroad as a solution to its human resource problems, and identifies current immigration policies as a problem

[10] This issue was raised by a number of participants at the Minister's Skills Dinner, which was held in the spring of 1998 to allow government officials to consult with industry representatives about significant and emerging issues in the industry. See: Industry Canada, Aerospace Sector Summary Report. *Report on Consultation*, June 1998. See also: Human Resources Development Canada, *The Canadian Aerospace Sector: Overview of the Sector*, August 1998. This paper outlines the same issue, and notes a number of instances where U.S. companies have drawn experienced personnel away from Canadian companies or from Canadian subsidiaries of U.S. companies, in some cases with significantly higher salary and benefit packages. The recent Industry Canada study of skills and training issues also raised this issue, and provided a number of examples of competition among firms for experienced employees, including "aggressive hiring practices by U.S. firms." See: Industry Canada, *Assessment of the Skills and Training Situation in the Canadian Aerospace Industry*, Aerospace and Defense Industries Branch, 1999.

in this regard. Among the issues here are the difficulty with prior learning assessment and obtaining credit for certifications and diplomas from non-Canadian institutions.

Problems with spouses and family members of incoming workers being able to obtain employment in Canada have also prevented Canadian companies from hiring some personnel. This issue has been raised in a number of forums by industry representatives, although no firm numbers exist on the the extent of the problem. Recent reforms to immigration policy have addressed some of these issues, though at the time of writing. However, these reforms had not been made permanent.[11]

## Skill Gaps

### Skill Shortages

Skill shortages in the aerospace industry primarily involve the highly skilled technical and scientific workers. A recent survey of aerospace companies (Industry Canada, 1998) found that almost all companies experienced at least some shortages of skilled scientific, engineering or technical personnel.

The industry shares some skilled trades shortages with other industries, and competes with other industries for a limited supply of skilled trades. Skill shortages were cited in such production-related occupations as machinists, CNC programmers and analysts, tool and die makers, engineers, and engineer technologists. Skill shortages were most acute for workers with two to five years' experience.

Problems with skill shortages were reported as being more serious in the SME part of the industry (referred to as third tier) than in larger companies, though shortages are in all parts of the industry. Shortages of software skills have been reported in most parts of the aerospace sector, because of the growing use of computer technology. The shortages are most acute for experienced engineers with highly developed computer skills. Salaries in these areas are significantly higher (up to 50 percent higher) than for engineers and technologists with similar levels of experience.

[11] See the report on the Minister's Skills Dinner, where this issue was raised by industry representatives. As the report on skills issues undertaken recently for Industry Canada has pointed out, there is some evidence to suggest that the role of foreign recruitment has diminished in recent year, perhaps because of improvements in some Canadian educational programs in this sector. However, since this is a cyclical phenomenon, the need for foreign recruitment could recur at a later point in the industry's cycle. See: Industry Canada, *Assessment of the Skills and Training Situation in the Canadian Aerospace Industry*, Aerospace and Defence Industries Branch, 1999.

There are also shortages in some management categories, especially those related to cost control. Since the major assemblers are changing their relationships with the major suppliers, project management skills, communications skills combined with technical and engineering skills, and combinations of management and computing skills may be in short supply. Some major companies reported that the single most important skill shortage was in the area of engineers with business, management and entrepreneurial training.

## Brain Drain

Two factors appear to be behind skill shortages of experienced employees in high skill areas: the drain of middle level people to the United States, where pay and advancement opportunities are more attractive; and the cyclical nature of the industry, which makes it difficult to keep good personnel from one production cycle to the next.[12]

### Time Lags

Time lags in training are particularly important in this industry because of the cyclical nature of production and demand. Most skilled trades require at least four years of training, and the industry has traditionally had some difficulty coordinating supply and demand for experienced workers over more than one business cycle. The result has been layoffs that affect the image of the industry and drive experienced workers to other industries, followed by shortages that result in production bottlenecks or bidding wars between companies and national industries for experienced personnel.

Most recent surveys of the industry have suggested that coordination and time lag issues — rather than the ability of the educational and training systems to turn out enough trained personnel — is the single most important human resource issue.[13]

[12] It should be noted that the brain drain issue is related to the cyclical nature of the industry, and is most serious when the industry is expanding quickly and hiring large numbers of new employees in a short period of time. Most large companies interviewed for this project did not identify brain drain as a major problem for them. However, it may be a more serious issue for smaller companies.

[13] In fact, most industry and educational people interviewed expressed general satisfaction with the quantity and quality of entry-level employees, although extra training upon hire is almost universal in this industry. This training can range from several days of orientation to several months of company-specific training, which is not unusual for entry- to mid-level technicians and technologists hired by the larger primes and systems integrators.

# RECRUITMENT, TRAINING AND DEVELOPMENT PATTERNS

## Training Effort in the Industry

"One of the reasons Canada has failed to adapt new technology quickly or be as innovative as our competitors is that the Canadian industry invests so little in training. Opportunities to adapt new technologies are lost because companies have no one who is familiar with the technology and could introduce it to others." (cited from Human Resources Development Canada, HRDC, literature review of the aerospace industry, 1995)

Industry Canada's most recent statistical survey of the industry (summer 1998) reports that training as a share of total industry costs was somewhat below the average for all manufacturing, and that the training effort in the industry was declining in the 1990s. R&D spending, however, was significantly higher that for manufacturing as a whole, and amounts to about a seventh of all R&D undertaken by Canadian industry.[14]

In spite of the finding of low overall training effort, several companies, especially first-tier companies, have in-house training programs devoted to upgrading current employees and keeping skills current. Some (for instance Pratt and Whitney) have their own training institutes that concentrate on upgrading and retraining.

## Recruitment Issues

The HRDC literature study suggests that there is a traditional practice in the industry of hiring not directly out of university or colleges, but instead attracting experienced workers from other companies in the sector, from other sectors or from abroad. This practice seems to be related to the project orientation of the work, which places value on worker's ability to work in teams and familiarity with the industry's work structure. This differs from production work in most other manufacturing sectors.

Methods of assessment of prior learning are a major issue because of the practice of recruiting abroad. While diplomas from recognized institutions are readily accepted, skilled tradespeople

[14] Interviews done for this project reported training expenditures in the major Primes and systems integrators ranging from a low of 2 percent of total wages and salaries up to 3.5 percent. Training effort in the smaller third-tier component suppliers is somewhat lower. Data from 1997 indicate that training costs in the industry as a whole represent 1.2 percent of payroll.

and experienced production personnel are often reluctant to move to Canada unless their previous experience can be recognized and validated. There is a feeling among industry officials that the current methods of evaluating the skills of foreign professionals are too rigid and should be made more flexible.

To a certain extent, the preference for experienced workers in this industry is related to past experience with entry-level employees. A 1998 survey by the National Aerospace Human Resources Committee reported only moderate levels of satisfaction with entry-level employees from universities and community colleges. In particular, the survey found that skills such as teamwork, problem solving and decision making, work ethic, computer literacy, cost control, and mechanical aptitude were only partly satisfactory.

Traditional preferences for experienced workers may be changing as the nature of work in the industry changes and advanced computer and design skills that require recent formal training become more important. This issue has been flagged in the literature, but with little supporting information.

## Formal Training and Relationships with Educational Institutions

A number of occupations in the industry require special licences or certificates. These occupations include technical personnel in the repair and overhaul sector (Aircraft Maintenance Engineer's, AME, licence granted by Transport Canada but requiring formal training as well as experience), qualified machinists and aerospace engineers. These requirements have fostered close relationships between the industry and many educational institutions.[15]

Co-op programs, apprenticeships, internships, and other formal and informal placement schemes play an important role in training future employees, although the industry has a marked preference for hiring experienced employees, as opposed to new graduates. The National Aerospace Human Resources Committee survey found that about half of the companies surveyed participate in apprenticeship programs, and that co-op placements are a common way of identifying and recruiting future employees.[16]

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[15] This refers as well to the repair and overhaul part of the aerospace sector, which is not included in this profile. However, there is some overlap in personnel between the two sectors, including some movement back and forth, and personnel in both sectors are trained in the same educational institutions and are employed in both sectors.

[16] National Aerospace Human Resources Committee, *Final Report*, January 1998.
Industry Canada, *Assessment of the Skills and Training Situation in the Canadian Aerospace Industry*, Aerospace and Defence Industries Branch. 1999. (Underdown Report).

Several collaborative initiatives, involving industry, government and the educational sector have emerged in the industry. These initiatives are particularly well developed in Quebec. Some of these initiatives are described in the "Best Practices and Case Study Profiles" section of this profile. Industry Canada reports that 19 community college level institutions and 11 universities provide training for the aerospace industry. (*See the sub-section entitled "Colleges, Universities and Trade Schools" for a list of these institutions. Detailed curriculum information is available from the recent HRDC literature survey of the industry.*)

Several universities provide specialized aerospace engineering programs as well as graduate programs. Graduates of these programs are recruited directly into the industry, although they must often compete with experienced specialists from other countries, since international hiring is an established practice in this industry.

Of the large number of programs devoted to the aerospace industry at community colleges across Canada, most are devoted to aircraft maintenance rather than manufacturing or production specialties. Industry representatives contacted by Industry Canada officials reported that, since few programs are devoted specifically to manufacturing and design, the industry must look outside of Canada for qualified production and design staff.

# OVERVIEW: KEYS AND OBSTACLES TO SUCCESS

While the aerospace industry has been growing steadily in the past few years, the percentage of Canadian value added in shipments has been falling, as a result of the difficulties Canadian second- and third-tier companies have in winning supply contracts in competition with companies from other countries.

The most significant factors affecting the competitiveness of Canadian suppliers include not only price, but also capacity to take on design and engineering work and share the financial and technological risks of developing new products.

R&D support from governments, as well as other forms of financial support, is a major factor that allows suppliers to take on the technological and financial risks of bidding on large contracts. Industry officials in the AIAC regard this as the single most important issue facing the industry.

Interviews with industry officials indicate that primes in Canada do not generally regard skill shortages in the Canadian industry as the most important factor for their success in coming years. This is because they are free to source internationally, and regard financing, marketing and political factors as being more important than skills issues in the Canadian industry.

For second- and third-tier suppliers, however, addressing shortages in a series of critical skills, chiefly those related to design and to the adaptation of new technologies to aerospace markets, will be important factors for their success. These skills will affect their ability to perform the design and other creative work that is being pushed up the supply chain.

The technology, design and manufacturing skills of supplier companies will determine whether or not major companies source in Canada or in other countries, and will be a factor in the success of SMEs in the industry. These skills, in turn, are related to the ability of Canadian companies to get a steady supply of design, technical, computer and managerial skills, or to create the processes in industry or the educational community to upgrade current skill sets in these areas.

# BEST PRACTICES AND CASE STUDY PROFILES

## Sector Groups

CAMAQ (*Centre d'adaptation de la main d'oeuvre aérospatiale du Québec*) was established in 1983 with involvement from representatives of all stakeholders in the industry, including aerospace companies, the provincial government and unions. It focusses on initial training, retraining and upgrading in skilled trades specific to the aerospace industry.

The Ontario Aerospace Council, through a cooperation agreement between the provincial government, five Ontario community colleges and Ontario-based aerospace companies, is engaged in several projects to upgrade the skills of current production employees in the industry. The most important of these is the Aerospace Industry Training Program (AITP), which was initially developed with the advice of CSTEC (Canadian Steel Trade and Employment Congress), a human resource council based in the steel industry that pioneered a sectoral approach to industry training and upgrading programs. The emphasis is on developing industry-wide transferable skills. At present, the AITP provides training courses through community colleges leading to certificates in aerospace management and program and contracts management. In connection with this program, the Council has developed a Prior Learning Assessment and Recognition (PLAR) process to assess existing skills in the industry. The Council examining how specific companies use different skill sets and how this information can be used to develop industry-wide skill standards.[17]

The Manitoba Aerospace Human Resources Coordinating Committee (MAHRCC) was established in 1992 to develop training programs for future and existing employees. It is supported through an ongoing cooperative agreement among a number of aerospace companies, including Standard Aero, Bristol Aerospace and Boeing, and the federal and provincial governments. Among its activities are the development of several cooperative education and apprenticeship programs and the design and development of aerospace-related courses at the University of Manitoba, Red River College and the Winnipeg Technical Vocational High School (Tec Voc). MAHRCC has also worked with a number of universities in other western provinces to develop university programs in aerospace. In connection with these programs, MAHRCC and Red River College have also worked with Bristol Aerospace and other aerospace companies to develop a PLAR process.[18]

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[17] The AITP is discussed in a presentation by Rod Jones, Executive Director of the Ontario Aerospace Council, National Aerospace Skills Symposium, *Final Report*, May 1999.

[18] MAHRCC and its activities in Manitoba are discussed in a presentation by Darcy Phillips, Executive Director of MAHRCC, Bruce Clark of Standard Aero and Wendall Weibe of Bristol Aerospace, National Aerospace Skills Symposium, *Final Report*, May 1999. MAHRCC also made a detailed presentation to the Skills Panel on its

## Colleges, Universities and Trade Schools[19]

EMAM (*École des Métiers de l'aérospatiale de Montréal*) opened in 1994, to train in specialized trades useful to the industry, including production-related trades. It is a joint initiative of CAMAQ, the Quebec Government, and the Montréal Catholic School Commission. Aerospace companies affiliated with EMAM supply teachers drawn from their skilled personnel, materials, and equipment. Companies also provide work placements, and use the school for upgrading and retraining employees.

University College of Cape Breton (UCCB) in Nova Scotia has a new Bachelor of Technology (Manufacturing) degree program that builds on relationships between UCCB and aerospace employers such as Pratt and Whitney and IMP. Companies such as Pratt and Whitney have traditionally taken a large percentage of the school's mechanical technology graduates, and have worked with the school to attract more female students into mechanical engineering through entrance scholarships. Aerospace companies provide placement for students from the engineering and technology programs, and have had input into the curriculum. UCCB has developed prior learning assessment instruments to enrol aerospace industry employees, and delivers some of its courses by distance education.

Co-op placements and arrangements to place students in work situations as part of their training are widespread in the industry, both at the secondary and college levels. The following list is a representative listing of partnership arrangements that focus on continuing training and the exchange of personnel between educational institutions and aerospace companies.

École Polytechnique in Montréal, and Spar Aerospace have a long-term arrangement to cooperate on the development of new space technology. Spar officials conduct research at the institution, provide some equipment, and provide placement for students.

École Polytechnique also has a long-term arrangement with Bombardier-Canadair: a special undergraduate concentration (30 credits — one full year) in mechanical engineering. Most of the

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activities with Red River College, University of Manitoba, Tec Voc High School and the PLAR initiative. *Presentation to the Expert Panel on Skills by MAHRCC*, May 1999. This is available through the Advisory Council on Science and Technology, Documentation Centre.

[19] The following list is a short summary of some of the most significant programs that supply the aerospace industry. A more detailed list is available in the following: Industry Canada, *Assessment of the Skills and Training Situation in the Canadian Aerospace Industry*, Aerospace and Defence Industries Branch, 1999 (Underdown Report). This report contains the most complete recent information on educational programs serving the industry.

courses are taught by Bombardier engineers. Students admitted to the concentration have a good chance of securing internships as well as full employment after graduation.

École Polytechnique, McGill, Concordia, Université de Sherbrooke, and Université Laval offer a joint master's degree in aerospace engineering in cooperation with about 15 aerospace companies in the Montréal area. The companies contribute to the teaching (often in "case study" format) and provide co-op training. In a typical year, upwards of 25 students graduate from this program.

Several other universities offer specialized aerospace programs, including Carleton University, which offers a bachelor of aerospace engineering, and the University of Toronto, which offers both undergraduate and graduate programs (to doctoral level) in aerospace science and engineering. Undergraduate courses in both these cases include co-op and work experience components.

CAE and Concordia University have an agreement to work on the development of flight simulator hardware and software. CAE personnel do research through Concordia and provide facilities for university staff to conduct research on practical applications.

ENA (*École national d'aéronautique*) at Collège Édouard Montpetit in Montréal has developed a program that focusses on aerospace manufacturing technology. In addition to full-time students, ENA has a continuing education program and a CAD/CAM centre that is used by industry personnel. ENA also administers a number of co-op programs with aerospace companies and exchanges students with foreign schools and companies.

Similar manufacturing technology programs are available in Ontario at Sheridan College, which offers engineering technology courses with and without co-op placement options. Among the activities at Sheridan College are a partnership with IBM and Pratt and Whitney for training in Computer-Assisted Three Dimensional Interactive Application (CATIA), a suite of software applications that is becoming the standard for design work in the aerospace industry. Sheridan also offers a joint program with McMaster University leading to a Bachelor of Manufacturing Technology degree, geared to current engineering personnel who require upgrading. This program is not specific to the aerospace industry, but includes placements in aerospace.

# APPENDIX I: SOURCE DATA

## Publications

Aerospace Industries Association of Canada. *Canada's Aerospace Industry: 1997 in Review.* 1998.

Aerospace Industries Association of Canada. *Is Your Future Up In the Air?* 1998.

Aerospace Industries Association of Canada. *AIAC Guide to Canada's Aerospace Industry.* 1998.

Aerospace Industries Association of Canada. *1998 Annual Review.*

Airbus Industrie. *Global Market Forecast 1997-2016.* Available on Airbus Web site **(http://www.airbus.com/gmf97/index.html)**.

Boeing Corporation. *Boeing Commercial Airplanes — Current Market Outlook: World Market Demand and Airplane Supply Requirements.* Available on Boeing Web site **(http://www.boeing.com/commercial/cmo/index.html)**.

Bombeau, Bernard. "Regional manufacturers," *Interavia, Business & Technology.* Vol. 52, May 1997, p. 33.

Bulloch, Chris. "Space business set to quadruple by 2010," *Interavia, Business & Technology.* Vol. 52, November 1997, p. 8.

Condom, Pierre. "Fighting king cost," *Interavia, Business & Technology.* Vol. 52, October 1997, pp. 26-29.

Cook, Nick and Duncan Macrae. "High stakes in aerostructures," *Interavia, Business & Technology.* Vol. 52, March 1997, pp. 14-17.

Davidson, Brian. "Bright outlook for business aircraft." *Interavia, Business & Technology.* Vol. 52, December 1997, p. 9.

Dupont, Jean. "Meeting the A3XX avionics challenge." *Interavia, Business & Technology.* Vol. 53, 1998.

Employment and Immigration Canada. Human Resources in the Canadian Aircraft Maintenance Industry, 1991.

Flint, Perry. "900 in '98." *Air Transport World.* Vol. 34, May 1997, p. 24.

Gravelle, Michelle. *Skills Challenges Facing Key Sectors of the Canadian Economy; A Consultation Report.* (Report on Skills Dinners) August 1998. Industry Canada. Typescript.

Greenslet, Ed. "Crystal gazing in the jet transport market." *Interavia, Business & Technology.* Vol. 52, September 1997, pp. 33-37.

Guyon, Janet. "The sole competitor." *Fortune.* Vol. 137, January 12, 1998, p. 102.

Human Resources Development Canada. *The Canadian Aerospace Sector. Overview of the Sector,* August 1998. [Typescript].

Human Resources Development Canada. Literature Review of the Canadian Aerospace Manufacturing Industry, 1995.

Human Resources Development Canada. Demographic Study of the Canadian Aircraft Maintenance Industry, March 1996.

Industry Canada. *Aircraft and Aircraft Parts. Part 1 — Overview and Prospects.* Sector Competitiveness Frameworks Series, 1996.

Industry Canada. Aerospace Sector Summary Report: Report on Consultation. (Report on Skills Dinner), June 1998.

Industry Canada. *Canadian Industry Overviews.* Available on Industry Canada's *Strategis* Web site.

Industry Canada. *Canadian Industry Statistics.* Available on Industry Canada's *Strategis* Web site.

Industry Canada. *Assessment of the Skills and Training Situation in the Canadian Aerospace Industry* (Underdown Report). Aerospace and Defence Industries Branch. Final Report, January 1999.

Industry Canada. *Handbook on Total Quality Management.* Aerospace and Defence Industries Branch, 1998.

Industry Canada. Quality in Action. *ISO 9000 as a Basis for Continuous Improvement.* Aerospace and Defence Industries Branch, 1997.

Macrae, Duncan. "Can Boeing cash in on commercial aviation upturn?" *Interavia, Business & Technology.* Vol. 52, July/August 1997, pp. 11-12.

McClenahen, John S. "Flying high, Boeing isn't soaring: process changes are taking longer than anticipated." *Industry Week.* Vol. 247, January 5, 1998, p. 10.

National Aerospace Human Resources Committee. *Final Report,* January 1998.

National Aerospace Skills Symposium. Final Report. May 1999. Available through Industry Canada's Aerospace and Defence Branch, and on Industry Canada's Web site **(http://strategis.ic.gc.ca/SSG/ad03414e.html).**

Pearlstein, Sam. "U.S. subcontractors set for the good times." *Interavia, Business & Technology.* Vol. 53, 1998.

Phillips, Edward H. "U.S. Airlines Brace for Market Turbulence." *Business Week.* November 9-16, 1998.

Robert, Olivier Louis. "Canada and the ISS." *Spaceflight.* Vol. 39, April 1997, p. 113.

Robert, Olivier L. "SpacePort Canada." *Spaceflight.* Vol. 39, May 1997, p. 158.

Sutton, Oliver. "Airbus snaps at Boeing's heels in 1997." *Interavia, Business & Technology.* Vol. 53, 1998.

Sutton, Oliver and Condom, Pierre. Bombardier, *AI® kick off 70-seat jet race.* Citation: *Interavia, Business & Technology.* Vol. 52, March 1997, p.33-35.

Sutton, Oliver and Duncan Macrae. *Competition hots up in the MRO business.* Citation: *Interavia, Business & Technology.* Vol. 52, December 1997, pp. 37-40.

Sweetman, Bill. "PW gears up for engine offensive". *Interavia, Business & Technology.* Vol. 53, 1998.

Sweetman, Bill. "PW eyes new engine programmes." *Interavia, Business & Technology.* Vol. 52, December 1997, p. 5.

Tardif, Christal. "Europe revamps aerospace R&D strategy." *Interavia, Business & Technology.* Vol. 52, November 1997, p. 28.

Tardif, Christal. "New engines boost performance of future models." *Interavia, Business & Technology.* Vol. 53, 1998.

**Web Sites**

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| Aerospace Industries Association of Canada | **http://www.aiac.ca** |
| Canadian Aviation Maintenance Council | **http://www.camc.ca** |
| Canadian Auto Workers | **http://www.caw.ca** |
| Canadian Defence Industries Association | **http://www.cdia.ca** |
| *Strategis* | **http://strategis.ic.gc.ca** |

## Interviews

Serge Tremblay, Directeur exécutif, Centre d'Adaptation de la main d'oeuvre aérospatiale au Québec (CAMAQ)

Michel Gagné, Pratt &Whitney Canada Inc.

Daniel Guertin, Directeur, Programmes gouvernementaux, et Luc Mallette, Directeur, Ressources humaines, Marconi Canada

Charles Dieudé, Directeur de la Direction aérospatiale et défense, Ministère de l'industrie, du commerce, de la science et de la technologie (MICST) du Québec

Nicole L'Écuyer-Demers, vice-présidente, Ressources humaines, Bombardier Canadair

Daniel Verreault, Vice-President Policy and Research, Aerospace Industries Association of Canada. (AIAC)

Bill Weston, Executive Director, Canadian Aviation Maintenance Council (CAMC)

Stu Sullivan, Executive Director, Aerospace Industries Association of Nova Scotia (AIANS)

Diane Huard, Department of National Defence, Centre for Research and Development (CRAD)