"Pay-to-Play"

Implications of Risk Sharing and Contribution Arrangements for Canadian Companies

A Report to the Ontario Ministry of Enterprise, Opportunity and Innovation

Draft for Comment

March 27, 2003

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Table of Contents

About this Report

This report was authored by Michael Grant, Principal, Grant Insights. The author recognizes the assistance of Amy Cooper, Research Associate, Grant Insights. The editor was Ena de Jong.

Acknowledgements

The author would like to thank the interviewees listed in Appendix A for sharing their insights into the issue of pay-to-play. Lucie Boily of Industry Canada deserves special mention for her help in providing contacts and her overall support for the project.

This report was supported through a financial contribution by the Ontario Government, Ministry of Enterprise, Opportunity and Innovation.

Executive Summary

- Pay-to-play is a new way of organizing the development of new product platforms in aerospace and the auto industry
- The term "pay-to-play" has been used to describe many different type of relationships between Original Equipment Manufacturers(OEMs) and sub-suppliers
- The report defines pay-to-play as "any development program for a new product "platform" that requires an upfront financial commitment by a supplier before that supplier may participate in the program. The supplier shares in both the risk and the return of the product."
- This definition is sufficiently broad to include a variety of joint-government development programs, but narrow enough to exclude the many arrangements between suppliers that are not really platform-driven.
- The study looks at two broad types of pay-to-play: company-to-company and government-to-government.
- There are three main factors that have a bearing on the pay-to-play: the nature of product development, industrial organization and financing. None of these factors are static.
- The report considers pay-to-play within the context of the research and development process.
- Pay-to-play has also affected the economies of scale and scope within the aerospace industry. This has particularly affected the second tier and may also affect the 3rd and 4th tier.
- Pay-to-play requires a greater level of financial depth in order to take on the require development costs.
- The benefits of pay-to-play are realized out of the emerging cash flows. The pattern of cash flow will vary according to the nature of the product, the investments and the resulting sales. These tend to be shared proportionately among the pay-to-play partners.
- The interviews for this study suggested that pay-to-play will become the norm for commercial aircraft development and will likely account for well over half of the new defence platforms.
- The study highlights a number of specific examples of pay-to-play.
- Although much is made of how pay-to-play arrangements redistribute risk, in many ways they also mitigate risk.
- If the government is going to support company-to-company platform development, it makes the most sense for it to go as far as it can to align its risk with its return.
- Given the long gestation periods for pay-to-play investments and the relatively recent experience with these arrangements, a definitive determination of the efficacy of pay-to-play is premature at this time.
- It would be beneficial to conduct further research on pay-to-play before committing additional government resources to these programs.

1. Introduction

It is widely acknowledged that the pace of technological change is accelerating and that a nation's technological prowess is related to its success in the global economy. There may be an initial tendency to view technology in the narrow sense of scientific research. But equally important is the way that scientific research is related to development of new products and processes that are valued in the marketplace. At another level, process innovations such as "lean production" have affected the way these new products are produced. These process innovations have changed the relationships between sub-suppliers and original equipment manufacturers (OEMs).

There are several things going on here:

- An appreciation for fundamental scientific research;
- The desire to link scientific research to the development of new products;
- Changes in the way suppliers co-operate to actually develop and manufacture products to satisfy the needs of the marketplace.

All this has inevitable implications for the financing of innovation and the allocation of risks and returns. As witnessed by recent federal and provincial budgets, governments are increasingly keen on providing more funding for innovation. To this point, these efforts have been particularly targeted at fundamental scientific research, which has greatly benefited university and government labs. But there are calls to also enhance support to the development phase, which is more the preserve of companies. At the same time, this development phase has been complicated by the evolving relationships between OEMs and suppliers.

As in any rapidly evolving situation, industry players and policy makers are grappling with the meaning of the changes for their world. A confusing array of terms is used to describe what is going on. The concept of "pay-to-play" is a good example.

Fundamentally, a pay-to-play initiative is one where a lead development organization asks its sub-suppliers to make financial commitments to joint development costs. In some cases there will be a financial transfer from the sub-supplier to the OEM to pay for common costs, such as compliance costs. Yet the pay-to-play terminology has also been used to describe a wide range of other arrangements, including the joint government research, space initiatives and defence procurement. To further confuse things, the recently announced Ontario government commitment of $625 million for the auto sector was considered by some as a "pay to play" initiative.[1]

Elsewhere in the auto sector, General Motor's Current Savings Program has also been described as "pay-to-play".[2] The program required certain suppliers on high-volume programs to make an upfront payment on the savings GM expected them

to realize over the life of their contract. This program is basically a performance bond that is tied directly to the supplier's commitment to reaching cost targets. Indeed, the term pay-to-play is often heard in relation to many supplier relationships where upfront commitments are made between supplier and customer that may ultimately cost the supplier money or require them to finance additional resources.

A Working Definition of Pay-to-Play

So the term "pay to play" is sufficiently elastic to mean many things to many people. It is therefore necessary to define the term more specifically for the purposes of this study. For our purposes, pay-to-play is:

> *Any development program for a new product "platform" that requires an upfront financial commitment by a supplier before that supplier may participate in the program. The supplier shares in both the risk and the return of the product.*

Product platforms form the basis for organizing many sub-supplier inputs. These are usually related to very expensive new products, like new-generation civil and defence aircraft and global positioning satellites. They are distinguished from newer versions of existing platforms (e.g., versions of the Boeing 747). Pay-to-play may also apply to autos, but is most likely in cases of major new models. There are two types of platform development programs: current platforms for products that will be commercialized typically within five years, and demonstration platforms for products that will be developed over the next 10 to 20 years. The latter, of course, are somewhat more speculative and therefore risky.

The cost of developing major platforms is huge. For instance, one interviewee for this study suggested that the development cost associated with the Airbus A380 was in the neighbourhood of $20 billion. The sheer scale of these development programs is such that they tend toward an oligopolistic structure where there are only a few major players sell the end product.

This definition is sufficiently broad to include a variety of joint-government development programs, but narrow enough to exclude the many arrangements between suppliers that are not really platform-driven. The relationships between OEMs and suppliers are continually changing what the supplier does for the OEM as well as additional supplier commitments on cost and quality. But in the joint development of major platforms, the relationship between a lead organization and sub-suppliers is significantly transformed in terms of risks and returns as to warrant separate attention, especially in terms of policy responses.

There are two main types of pay-to-play programs that are considered: government-to-government and company-to-company. These different types of pay-to-play have very different rationales and dynamics in terms of risk and returns. For instance, in the case of government-to-government programs, taxpayers make an upfront financial commitment in the name of national

suppliers. This is, of course, very different from commercial pay-to-play, which is more directly related to shareholders' financial commitment and willingness to take on risk with an eye toward a financial return.

In addition to "play-to-play", this report will also refer to these arrangements as "risk-sharing arrangements" or "contributions for participation". The idea of "risk sharing" was first introduced by Bombardier in the mid 1990s as a new basis of partnership with its key suppliers. The concept of contributions for participation is more of a government-to-government concept, where a government's contribution allows its national firms to participate.

Purpose

The purpose of this study is to provide the reader with an understanding of the concept of pay-to-play. The report will explore the nature of the pay-to-play arrangements and what they mean for the development risk and return. The report will also explore the implications for both manufacturing companies and for government policy.

This is not an advocacy report. The various manufacturing sub-sector industry associations are very good at advocating in favour of government financial support to fund their members' development costs. Although the report does not make a final judgment on the efficacy of such support, it does explore the arguments both in favour and against. The intention here is to provide a balanced analysis, based on current information, and to suggest some other research that might enlighten the debate.

Methodology

This report is based on two research methodologies: a thorough review of the literature (see References) and interviews with various industry experts (Appendix A). Interviews were conducted during the months of February and March 2003. In order to protect their confidentiality, interviewees are not mentioned by name.

A Guide to the Report

The report begins with a review of the concept of pay-to-play. It sets out a framework for understanding what is going on by considering interactions between the research and development process, industry structure and financial structure. The public policy case is based on perceived market failures in funding research and development, and the arguments about this are considered. The report continues to look at the current practice on pay-to-play. It then provides an assessment of the impact of pay-to-play on companies and governments. The report concludes with suggestions for further research.

2. A Framework For Understanding Pay-to-Play

There are three main factors that have a bearing on the pay-to-play: the nature of product development, industrial organization and financing. None of these factors are static; they are constantly evolving to changes in the marketplace and in core technologies. This evolution affects the fundamental economies of scale (i.e., some things are done better when an organization is large) and scope (i.e., some things are done better when an organization has depth of expertise).

Canada is what economists call a "small open economy". So when we look at an industry through nationalistic lenses, we see a manufacturing sector that specializes in a few key areas and is highly dependent on international trade. This specialization has been further encouraged because of our fortuitous position adjacent to the major industrial juggernaut of the United States.
It is well known that integration with the United States economy has grown significantly since the 1989 Free Trade Agreement. This has especially affected the integration of the auto, aerospace and defence industries.

The Organization of Product Development

Improvement in information and communication technology means that the research and development process is organized increasingly on a global scale. This is certainly true of university-based fundamental research, which has become very specialized as it has become more globalized. When knowledge generation is organized in this way, it becomes somewhat more difficult to distinguish "Canadian" innovation from "non-Canadian" innovation. Canadians are effectively making a variety of contributions to the global stock of knowledge. Canada is one of the world leaders in international technology partnerships.[3] Although there may be prestige associated with uniquely Canadian innovations, these typically are relatively few and, at any rate, are disconnected from the processes that lead to higher levels of productivity and growth.

As one moves away from fundamental research toward engineering development for production, the process becomes more fragmented and intertwined with industrial performance. This does, arguably, have a much larger impact on productivity and growth because it is closer to the point where people are employed to produce goods for the marketplace. Even in instances where foreign-owned second tier suppliers undertake development, Canadian subsidiaries will be involved in competing for global product mandates. Their success at winning these mandates is very much entwined with the level and nature of employment.

This process has led Canada to develop a world reputation in niche markets. This includes landing gear, environmental systems, regional aircraft and helicopters One interviewee described Canada's expertise in aerospace as "deep and narrow". Given the size of the country and its relationship to the United States, this type of specialization is understandable and probably desirable.

Exhibit 1
Perspectives of the Research and Development Continuum and Relationship to Finance

Fundamental Research		Horizontal Technology Development		Vertical Technology Development		Engineering Development	
Universities	Corporate	Applied Research	Component Technology Development	Competency Development	Technology Demonstration	Advanced Manufacturing	Production

Research	Platform Development	Commercialization
Government Finance	Joint Finance	Private Finance

Source: Adapted from: Industry Canada (Aerospace and Automotive Branch). 2000. Canada's Aerospace & Defence Technology Framework. (Ottawa: Queen's Printer). p.4. and interview results.

Product Development and Industrial Organization

The commercialization of technology is a complicated process that involves many companies. Industrial research and development is organized around optimal economies of scale and scope. Companies will invest in research and development where they believe they have a comparative advantage in developing technologies and patenting innovation to exclude competing firms from marketing their innovations.

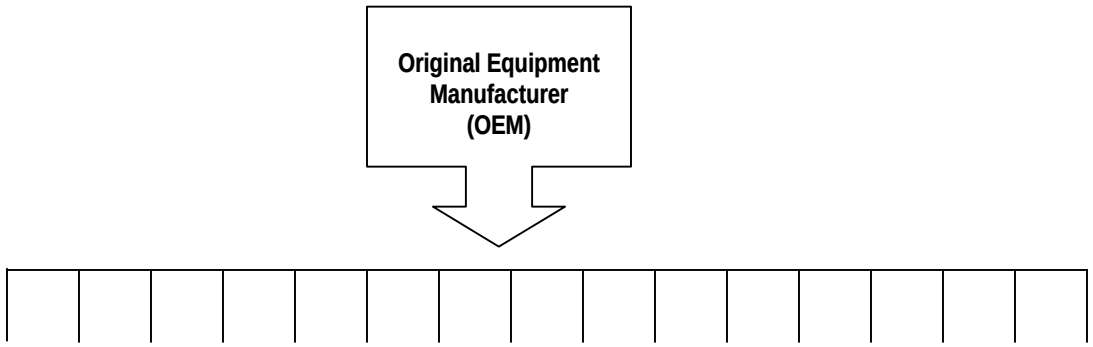
For large platforms like commercial and defence aircraft and satellite systems, there will be tendency for the largest firms to control core technologies that are essential to the end product. Increasingly, however, even large organizations have recognized that the innovation is best realized if it is not concentrated solely in large companies. Large organizations like Boeing and Airbus recognize that their value as an OEM increases when they focus on two things:

- Managing the process of innovation from fundamental research to production;
- Focusing on lean production techniques that depend on synchronizing production between them and their sub-suppliers.

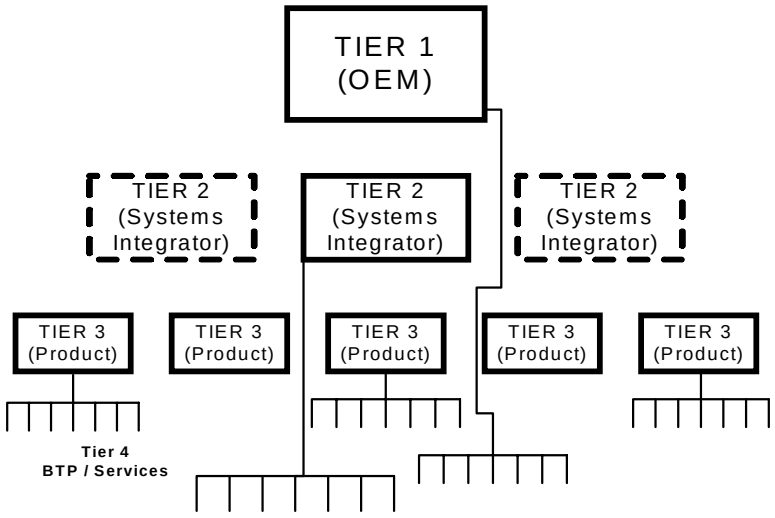
As such, OEMs get involved in virtually every aspect of the research and development process. At the front end, they work with universities and fund research institutes that focus on breakthroughs in core technologies. They work with these organizations to improve the linkages between fundamental research and applied research and develop platform demonstrations. They then develop their own core competencies to turn research into product innovations. Finally, they work with their sub-suppliers in developing components and integrating technologies.

Exhibit 2
The Organization of Production in Aerospace

Before



After



Source: Ontario Aerospace Council

OEMs like Boeing, Bombardier and Airbus are of sufficient scale to get involved in all these areas. Having said that, over time they have become less interested in controlling every aspect of the research and development process. Rather, they now make strategic decisions as to which technologies are important to their core competency and which are best managed through partnerships with research organizations and sub-suppliers.

The change in the relationship between OEM and sub-suppliers has a number of important implications. To begin, the OEM is less interested in doing all the development and then sub-contracting to many build-to-print suppliers. There are two reasons for this. First, the OEM benefits from the creation of a

competitive lower tier structure for component and systems integration. Second, it is easier to pursue lean production strategies when working with a few suppliers than with many sub-suppliers. So the OEM is looking for a few suppliers that have sufficient scale and staying power to maintain a long-term relationship of joint product development. The build-to-print function is now either being integrated at the second tier level or is being pushed down the supply chain. There are now effectively four tiers: OEMs, Tier 2 Systems Integrators, Tier 3 Product Producers and Tier 4 Build-to-Print Suppliers.

For industries like aerospace and autos, this means that second and third tier suppliers, such as Honeywell in aerospace and Magna in autos, are becoming larger and more sophisticated in the way they integrate technologies and co-ordinate their quality processes with that of the OEMs. As the second tier grows, they are also behaving more like the OEMs. So, for instance, the second tier is increasingly developing sub-platforms (e.g., Pratt and Whitney turbine engines). Moreover, interviewees pointed to the fact that the second tier is also looking to cut down on the number of suppliers. So the OEM's decision to work with fewer suppliers is effectively rippling through the various tiers of the industry. It is also redefining what is meant by "platform development".

This does not mean that the build-to-print industry will be completely wiped out. Rather, there are likely to be fewer build-to-print companies and those that survive will do so because of their manufacturing excellence. In this process there will be constant tension between the search for economies of scale and economies of scope. The underlying forces will always drive to the most efficient allocation of resources between small scale/flexible/innovative and large scale/cost efficient. This will affect the size and number of companies at the various tiers.

How does the current Canadian aerospace industry stack up against this structure of production? Table 1 considers other research that provides an estimate of the size of the various tiers. Build-to-print operators account for over half of the 500 aviation/aerospace operators considered in their survey. Yet most of the operations are fairly small; only half of all operators have over 50 employees.

Indeed, many of these operations will be serving other customers outside the aviation/aerospace sector. If the industry continues to consolidate toward the second and third tier, many of these operators will have a decision to make. They may either sell to larger concerns in a process of mergers and acquisitions, or choose to develop other aspects of their business outside of aerospace. Either way, the indications are that the lower tiers will not be able to avoid the movement toward fewer, larger suppliers.

Table 1
Estimates of the Size of Aerospace Manufacturing and Maintenance Tiers
Survey Estimates
n=518

	By Province						Canada
Characteristic	**Quebec**	**Ontario**	**Manitoba**	**Alberta**	**BC**	**Atlantic**	
Operators By Tier							
Tier 1(OEM)	2.6%	1.7%		10.3%	2.6%		**2.5%**
Tier 2(Systems Integrator)	4.2%	6.6%		10.3%	2.6%	7.1%	**5.4%**
Tier 3(Equip./Comp)	5.8%	17.9%	5.3%	10.3%	23.7%	14.3%	**12.9%**
Tier 4 (Sub-contract/BTP)	66.1%	46.3%	47.4%	10.3%	28.9%	64.3%	**50.8%**
Tier 5 (Maintenance)	10.6%	15.3%	47.4%	48.3%	34.2%	14.3%	**18.0%**
Other	10.6%	12.2%		10.3%	7.9%		**10.4%**
% of Revenues							
0 to 15%	36.5%	38.0%	36.8%	34.5%	28.9%	7.1%	**35.7%**
16% to 45%	14.3%	19.2%	10.5%	13.8%	5.3%	7.1%	**15.4%**
46% to 90%	22.2%	15.7%	5.3%	10.3%	31.6%	21.4%	**18.7%**
91%+	22.2%	24.5%	47.4%	41.4%	34.2%	57.1%	**27.0%**
Employees							
0 to 9	18.0%	33.2%	15.8%	27.6%	31.6%	14.3%	**26.1%**
10 to 19	15.3%	18.8%	26.3%	13.8%	21.1%	14.3%	**17.6%**
20 to 49	27.0%	21.8%	26.3%	24.1%	21.1%	28.6%	**24.1%**
50 to 199	27.0%	17.5%	10.5%	24.1%	13.2%	28.6%	**21.0%**
200+	11.1%	8.3%	21.1%	10.3%	13.2%	14.3%	**10.4%**

Source: Malatest and Associates Ltd. 2001.*Final Survey Report Vol.2.2.. Canadian Aerospace Labour Market Survey and Employment Forecast, 2001-2004*. Prepared for CAMAQ, OAC and MAHRCC. August.

Financing

In the build-to-print industry, it was possible for companies to have a fairly simple financing structure. The main concerns in investment planning were plant and equipment and inventories. As the build-to-print companies did little development, they were able to focus their attentions on process innovations. Many of these companies have adopted lean production techniques and applied concepts like Goldratt's Theory of Constraints.[4] This has allowed them to reduce inventories and leverage working capital.

Fourth tier companies have not typically been strong on research and development or training of employees. This was understandable given their role in the supply chain. But the tendency to push development down the supply chain has potentially serious ramifications for these companies. In addition to plant and equipment and inventories, some of these operators must now consider assuming some development costs and employing and training higher-skilled design employees.

In many ways, this places the small- and medium-sized lower tier operators in a difficult bind. Many of these are owner-operators will be lightly capitalized. For

instance, Industry Canada's survey of small enterprises in the aircraft and aircraft parts sector shows that, while profitable, many will lack the financial depth to take on major development projects.

Table 2
Comparative Financial Positions for Small and Second Tier Companies
Aircraft and Aircraft Parts Industry (SIC 3211)
Canada, 1997
(Average for Sample, Dollars)
n=40

INCOME STATEMENT		
	Small Firms	**Second Tier***
Gross Revenue	$ 1,004,200	$500,000,000
Cost of Goods Sold	$ 339,500	$125,000,000
Wages and Salaries	$ 299,000	$115,000,000
Occupancy Expenses	$ 72,200	$25,000,000
Financial Expenses	$ 32,400	$16,000,000
General Expenses	$ 35,900	$17,000,000
Other Expenses (including taxes)	$ 153,400	$76,000,000
Research and Development	$ 0	$75,000,000
Total Expenses	$ 937,200	$440,000,000
Net Profit	$ 67,000	$50,000,000
OTHER FINANCIAL		
Interest coverage ratio	7.8	10
Gross Margin	36.4	52
Common shares	n.a.	$150,000,000
Long-Term Debt	negligible	$100,000,000

Source: Industry Canada's Performance Plus data. See: http://sme.ic.gc.ca/. Author's estimate.
*Note: Second Tier is included for illustrative purposes only. based on author's estimate from company financial statements and interview findings.

While these companies are typically running profitable businesses, they are likely dependent on bank financing for their ongoing financial needs. As they move into development, they are effectively changing the nature of their business and their financial needs. A bank will extend working capital financing for owner-operators with a clear track record of sales and a solid balance sheet. In the build-to-print industry, the important thing is to make sales and manage an efficient production and distribution process.

Table 3
Canadian Aviation/Aerospace Second Tier Suppliers
Global Sales

Company	Key Expertise	Company-wide Global Sales
Boeing Toronto, Ltd.	Original equipment manufacturer with systems integration capabilities	US$ 54.6 billion[b]
Messier-Dowty	Landing gear systems	US$ 610 million[a]
Honeywell	Aircraft environmental systems	US$ 22.3 billion[b]
B.F. Goodrich Landing Gear	Landing gear systems	US$ 3.9 billion[b] (US$ 1.1 billion landing gear)
Pratt and Whitney Canada	Small and medium turbine engines	US$ 7.6 billion[a]
COM DEV Space Group	Satellite multiplexers and switches	$614 million[a]
Lockheed Martin	Systems integration	US$ 7.6 billion[a] (Systems Integration Business)
Macdonald Dettwiler Space & Advanced Robotics	Space Robotics	570 million[b]

[a] 2001
[b] 2002
Source: Company Annual Reports

If there is industry consolidation toward a development and production model, more suppliers will have to fund development costs. This is a very different financial proposition than the sales/production-financing model because the risks, returns and cash flow cycles are different. Specifically, as a company moves toward more development, it has to change its financial structure toward more long-term financing. This may prove difficult for third and fourth tier operators with little basis for collateralizing long-term loans.

Contrast this situation with that of second tier suppliers (Table 2). Many of Canada's second tier suppliers are subsidiaries of foreign multinationals with considerable financial wherewithal. These are integrated companies where the

Canadian operation is a facility operating within a larger corporate business unit. To be sure, these companies face internal competition for capital, but this is very different than small companies trying to work with the banking sector to secure long-term capital.

Notwithstanding arguments about nationalistic considerations, multinational companies do tend to be rational in the way they allocate capital among their subsidiaries. If a subsidiary demonstrates that it provide a good return on employed capital, it will be able to compete in the internal allocation of capital. These decisions are made on many factors including cost effectiveness and quality.

Commercial Play-to-Play Framework

The pay-to-play concept is not an innovation that can be separated from the broader factors driving industrial change. Rather, the concept is a natural development that is directly attributable to the changing nature of relationship between OEMs and sub-suppliers. These factors are being driven by customer needs, technology and the drive for continuous improvement.

As the OEM pushes development down to second tier systems integrators they continue to want to maintain control of quality. So the relationship is not, strictly speaking, an arms length one. Rather, there is a partnership between the OEM and the second tier that includes common approaches to development and quality management.

The evolution of pay-to-play is directly related to the closeness of partnerships between the OEMs and the systems integrators. In the first instance, the OEM undertook virtually all the research and development. The OEM would provide the lower tiers with drawings and often the tooling to allow them to build to their specifications (hence, build-to-print). They would also pay for "non-recurring engineering" costs.

Eventually, OEMs sought to move more costs off their books onto their suppliers' books. The first thing to go was non-recurring engineering costs, which were expected to be absorbed the sub-supplier. As the development relationship with second tier suppliers evolved, the OEMs asked these suppliers to make a contribution to joint development costs. These would include the costs and associated overheads of ensuring that the new product would pass regulatory approval—the so-called compliance costs. Hence, commercial pay-to-play is essentially how these costs are passed through to the lower tiers. In addition, lower tiers must assume a greater role in development and commercialization, which also costs them money over time.

Most of the pay-to-play costs are for platforms of products that will be commercialized within 5 years. As one interviewee noted, if a company spends 15 per cent of sales on research and development, about 13 per cent of sales will be

on the joint development of platforms. The systems integrator will make development commitments in line with their share of the overall product. For instance, landing gear may constitute 2 per cent of the total development and the landing gear manufacturer would be expected to take on 2 per cent of the total costs. This financial commitment may be made over the course of four years with most of the commitment front end loaded. So on a $1 billion development program the costs may amount to $25 to $30 million over four years, much of which is front-end loaded.

There has been some confusion around the extent to which an upfront cash payment is part of the deal. Although there may be payments for common development or compliance costs, industry sources suggested that the main financial commitment was in the form of a commitment to develop a component of the larger aircraft. There may also be cash transfers from the sub-supplier to the OEM, but these tend to be a matter of negotiation and are often rolled into price discounts. Of course, the sub-supplier shares commercial risk that is related to the ultimate sale of the aircraft. But the sub-supplier also assumes technical risk that its components can be successfully integrated with other components in the aircraft.

How Do Benefits Arise for Companies?

A common way of evaluating a future stream of benefits is through a discounted net cash flow. The movement towards joint development of platforms and sub-platforms changes the nature of sub-supplier cash flow. In the old model, the idea was to generate sales and make margins on production efficiencies. The main investment of resources was in production and logistics to ensure that the lower tier supplier could produce a product to OEM specification and make sure it was delivered when the OEM needed it. The cash flow cycles between revenue (sales) and costs (production) were actually fairly short.

Of course, these competencies are still important to lower tiers of the industry. But, in addition, organizations must develop proprietary products and systems. This involves funding research and development costs through the prototype phase and into full commercialization. This changes the nature of the discounted cash flow model. Effectively, an organization is now funding costs today that will not be reflected in net cash flow until far into the future. For instance, a regional jet platform may take five years to develop and, if successful, generate a cash flow some 15 years into the future. The enhanced cash flow is initially in the form of sales for new aircraft and there may also be some aftermarket sales that work into the computation of benefits.

This change complicates management for some organizations. Organizations still need to be effective marketers and efficient producers. But, in addition, they must be able to raise long-term capital and employ this capital wisely in development and commercialization. Similarly, the nature and extent of their risk has changed in line with their capital structure. Also, they now have to manage intellectual

property and employ a higher-skilled workforce that is capable of undertaking development. The nature of their balance sheet and non-balance sheet human capital has also changed. For these reasons, the basis for net discounted cash flow, which is the measure of how benefits of initiatives like pay-to-play materialize, is fundamentally changed.

Participants in pay-to-play arrangements also argue that there are other benefits from these arrangements that cannot be measured strictly from the cash flows of the project in question. Pay-to-play also leads to sharing of information and development of technologies that are applicable in other lines of products. Although these types of benefits definitely exist, it is very difficult to measure how important spillover benefits are on their own account.

As the pay-to-play initiative is of relatively recent vintage, it is difficult to say whether companies have yet to realize the benefits from their involvement. Given the current overcapacity in the aerospace industry, it is even more difficult to predict whether these arrangements will pay off in the future.

Government Pay-to-Play Framework

The changes in the funding of platform development do not, in and of themselves, constitute a financing market failure. There are many companies that are faced with a similar challenge in funding current development costs to generate long-term cash flow (think, for instance, of the mining sector). It does, however, change the business model under which some companies are operating.

Market mechanisms, left to their own devices, will align capital structure to anticipated discounted cash flow. However, globalized capital markets do not tend to take nationalist concerns into consideration when allocating long-term capital. Canada's share will be driven by its ability to provide a return on employed capital.

Yet, a key distinguishing feature of aerospace manufacturing and, to a large extent, the auto sector, is that there has been a lengthy history of government involvement. In the case of aerospace, the industry has been intertwined with security considerations and national prestige. Dating back to the 1950s there has been heavy government involvement in the industry as it was seen as being "strategic". Advocates of greater involvement cite government involvement in aerospace up to the 1980s as forming the basis for the success of the Canadian aerospace sector during the 1990s. These types of industry subsidies have been scaled back somewhat through the General Agreement on Tariffs and Trade and the World Trade Organization (GATT/WTO) negotiations that have sought to limit export subsidies.

The idea of government-centric success is a difficult claim to verify, as there are undoubtedly many factors that account for the successes of the Canadian aerospace sector. What is not questionable is that governments continue to play

a very prominent role in the global aerospace industry. In the United States, there are very close ties between government support for defence research and development and the spillover benefits to commercial aircraft. Moreover, research joint ventures (RJV) in the US were given impetus through the passing of the 1984 National Cooperative Research Act (NCRA) that set the conditions for cooperation without attracting anti-trust prosecution.

In Europe, Brazil and (increasingly) Asia, governments are at the forefront of developing the new technology demonstration platforms around which sub-suppliers will be organized in the future. In Europe, the most recent manifestation of government commitment to new platforms is the European Union's Sixth Framework Research Programme.

This level of government involvement makes it difficult to assess the industry on a strictly commercial basis. Government spending is either a direct subsidy to the research and development process of the industry or a contribution to risk sharing. Either way, it allows the industry to create economies of scale and technologies that are used in the commercial aspects of their business.

Canadian defence spending is clearly not in the league of US, even on a relative basis. Similarly, Canada has tended to avoid large-scale government-centric research and development spending programs along the lines of the EU Sixth Framework. The current approach is to support basic research through the universities and to support commercial development through a generous Research and Development tax credit system.

However, another option that is being pursued is to leverage limited research funds into the large research programs of other countries. As such, Canada is involved at various levels in such programs as the US Joint Strike Fighter Program, the EU Sixth Framework Program and its Galileo Satellite Navigation System.

The idea here is to position Canadian companies for work emanating from the development of these major platforms. Inasmuch as there is an upfront financial commitment before companies can participate in these platforms, this type of government-to-government participation is a form of pay-to-play under the working definition used here. However, it is a special class of pay-to-play and obviously the risks, returns and benefits are very different from a purely commercial pay-to-play platform development.

The main difference is that the broader taxpayers underwrite a portion of the financial commitment and risks. This is not to suggest that the commercial participants do not engage in risk. These programs typically require the industry to make a financial contribution—in the case of the Sixth Framework, on a 50/50 cost-sharing basis. But the taxpayers pick up half the risk, and this very significantly changes the private companies' evaluations of risk and return.

As with commercial pay-to-play, the benefits flow to the participating companies on the basis of their ability to compete within the rules of the framework. But from a discounted cash flow perspective, the upfront contribution of the taxpayer makes this an attractive proposition for the company. If the companies are successful, their discounted cash flow will increase. Depending on the nature of the arrangements, the government will attempt to recoup its invested funds through the tax system. The main differentiating aspect of the various government-to-government pay-to-play research and development frameworks is the extent to which a member government's commitment is related to guarantees that its national firms will benefit from subsequent procurement.

Another aspect of government pay-to-play along the lines of the European model is that it tends to be focused on "next generation" platforms with a very long gestation periods. These are the sort of platforms that potentially make legacy platforms quickly redundant. If the new platform is successful, it clearly benefits all the participants in the early stage of development.

3. Current Practice

To this point, the paper has reviewed the underlying forces that are driving pay-to-play. This section will elaborate by looking at some specific examples of the practice.

We have argued that there are two types of arrangements that can be considered pay-to-play: commercial arrangements between companies and government-to-government arrangements. Within these two broad classes there are many variations and permutations. Indeed, given the role of government financing in the aerospace industry, the lines between commercial and government pay to play can be blurred.

Still, the two main types are distinguishable because of the nature of the upfront financial commitment that sets the condition for subsequent participation. It is true that commercial pay-to-play may be effectively supported through government policies like research and development tax credits. Yet the primary funding mechanism is a company's own resources that are committed to a development program. On the other hand, government pay-to-play requires an upfront government financial commitment before companies can participate. There are no mechanisms in these arrangements for Canadian companies to participate without the official support of the Canadian government.

Exhibit 3 provides a summary of the main types of pay-to-play as defined by this report. The different types of pay to play differ in three respects:

- The extent to which commercial participants assume risk;
- The way the benefits materialize and are shared by participants, including spillover benefits;
- The timeframe for assessing risk and benefits.

We have identified one type of commercial pay-to-play and two sub-types of pay-to-play arrangements within government-to-government arrangements. The report will discuss each of these within the context of describing the specific programs that have been developed under these types of arrangements.

Commercial Pay-to-Play

A Canadian company, Bombardier, was actually at the forefront of developing the pay-to-play concept in the mid-1990s. Bombardier was interested in developing partnership arrangements with "risk sharing partnerships" in the mid-1990s. It has now applied the concept to every business and regional jet platform since then, including the Global Express and the RJ 700.

One of the reasons that Bombardier has more experience with this arrangement is that its platforms are considerably smaller and take less time to develop than, say,

large commercial aircraft. For instance, a Bombardier regional jet may cost $1 billion to develop over a four-year phase and have a sales life of 10 years. According to one interviewee, Boeing, for instance, has not developed a new platform since the B777. Major new commercial aircraft are more of an $8 billion proposition and will pay benefits over 20 to 30 years. Airbus has applied this concept to the A380 and the A400M, and emerging Boeing platforms like the B7E7 will likely be developed under a risk-sharing arrangement.

In the auto industry, the specific cases of risk sharing arrangements are harder to identify. Although there has certainly been greater integration between parts manufacturers like Magna and OEMs, the fundamental nature of auto manufacturing is completely different in terms of the scale of development, the technology integration issues and the risks and returns. Auto OEMs spread their risk over many model types and keep fairly tight control over design. Having said this, OEMs have made significant strides in integrating their quality control systems with lower tier suppliers. As with aerospace, this has lead them to develop close working relationships with a few suppliers like Magna. Occasionally, this has lead to a higher level of integration on design. So, for example, a Magna company designed the interior of the Cadillac CTS.

How significant are pay-to-play arrangements likely to be? The interviews for this study suggested that pay-to-play will become the norm for commercial aircraft development and will likely account for well over half of the new defence platforms. It is likely to be less important in the auto sector because of the major differences in the development cycles and risk profiles.

In the case of aerospace, Canadian firms spend about $1.2 billion on research and development.[5] The vast majority of this expenditure (probably 90 per cent) will go to jointly developed platforms using current technologies. Bombardier and second tier players such a Pratt and Whitney, Messier-Dowty, Magellan Aerospace, BF Goodrich Landing Gear, will spend most of this. To give an idea of the scale, a typical second tier producer in Canada with sales of about $100 million will spend about $15 million on platform development, most of which will go toward jointly developed projects.

A small portion will go to longer-term fundamental research efforts to discover breakthrough technologies. On a larger scale, these are called “platform demonstration” projects. Canadian industry does very little of this on its own account but has been looking to join other efforts at platform demonstration. This is where government pay-to-play comes in.

Exhibit 3
Types of Pay-to-Play

Government to Government		
Type	**Description**	**Examples**
Government pays for admission for national firms to bid with no guarantees	• No offsets or work share just right to bid • Right to access market and development information • Possible spin off benefits for firms in positioning for further work • Paid for out of Defence budget • Commercial risks are the same as company-to-company	Joint Strike Fighter Program
Government pays for admission for national firms to bid with guarantees	• Pay for right to work • Right to access market and development information • Guarantees of work in relationship to national contribution • Possible spin off benefits for firms materialize through positioning for further work • Commercial risks are less than other types because of guarantees • Ambiguities around ownership of intellectual property (IP)	European Fifth and Sixth Framework Research Programmes; European Space Agency Galileo Satellite Program.
Company to Company		
Company enters into joint development agreement with the OEM. May agree to pay common development costs (e.g., compliance costs). Assumes a portion of financial risk and return.	• Original equipment manufacturers convenes 7 or 8 systems integrators to jointly develop new product platform • Systems integrators agree to performance and cost targets • They assume financial and technological risk for their portion of the project • They fund development but also own intellectual property (IP) • Benefits emerge in form of sales of original equipment and aftermarket.	Airbus A380, A400M Bombardier Global Express, RJ 700 Boeing 7E7 GM Cadillac CTS Ford Explorer

Government Pay-to-Play

The Canadian government has begun to participate in arrangements where it makes an upfront contribution to a research and development program that is lead by either one country (the United States) or a number of countries (European Union). As opposed to commercial pay-to-play, the rationale for the government contribution may be based on its public good mandate, its desire to fund basic research or to generate employment.

The underlying idea is to position Canadian companies for a piece of platform development and to gain economies of scale on programs where Canada cannot generate these on its own account. As with commercial pay-to-play, these platforms will vary in terms of the period of time over which they will potentially pay benefits. For example, a program like the Joint Strike Fighter is geared to producing an aircraft platform over 10 years that will have 30 to 40 year sales life.

In Exhibit 3 we distinguish two types of government pay-to-play based on the extent of the guarantee that national firms through their government's contribution. In one case, the government is effectively making a contribution to the program buying a "seat at the table" in the bidding process. In a second type, there is a level of work guaranteed to national firms in relationship to the level of its government contribution. Although in both cases companies undertake joint development of the platform with the related risks and benefits, the somewhat higher guarantee of the second type of program has the effect of reducing an aspect of the commercial risk.

No Guarantee: The Joint Strike Fighter

The most noteworthy example of the "no guarantee" type is the Joint Strike Fighter Program. This is a joint US/UK program that will produce the F-35 fighter aircraft, which will replace a number of aging aircraft in the US and UK forces fleet. Lockheed Martin is developing the F-35 in conjunction with its principal partners are Northrop Grumman and BAE Systems. Two interchangeable engines are under development by Pratt & Whitney and General Electric.

In 1998, Canada contributed US$10 million to the concept demonstration phase of the project in 1998. Subsequently Canada has signed the memorandum of understanding (MOU) with the US and UK on February 7, 2003, committing it to the Systems Development and Deployment phase of the JSF program. This MOU will cover the next 10 years and cost Canada $150 million. Although there are no guarantees that Canadian contractors will win work, the Canadian Department of National Defence (who is supporting the program) may withdraw from the framework MOU and supplemental agreements if it deems that the Canadian company participation is unsatisfactory. It is expected that the entire program may generate sales of $400 billion over the life of the aircraft. Interviews for this study suggested that Canadian sales could be in the neighbourhood of 10

billion dollars if the companies participate through to the production phase of the program. These levels of sales are by no means guaranteed and their may be a tendency by the US and UK governments to favour domestic firms for much of the work. But given the high level of integration between US companies and their Canadian subsidiaries, Canadian companies will definitely get significant work from this program.

Partial Guarantee: Sixth Framework and Galileo

Another form of government pay-to-play is one in which national firms are guaranteed work in relationship to their government contribution. There are two noteworthy examples, both based in Europe. The European Union Sixth Framework Program is designed to fund platform demonstration projects in variety of areas including aerospace. These frameworks operate over five years and form the basis for joint co-operation. The EU will only fund projects with participants from several countries.

As Canada has signed a Science and Technology Agreement with the EU and has participated in the Fifth Framework, it has been granted full participation rights within the Sixth Framework. This allows Canadian research and development organizations to link their research projects to larger Sixth Framework Projects and to benefit from collaboration within the EU program. The guarantee is in terms of participation, but Canadian research organizations that participate in Sixth Framework consortia will effectively benefit from EU funding.

The EU has set aside €17.5 billion for Sixth Framework projects over 2002-2006. Of particular relevance to this report is the fact that about €1 billion is dedicated to aerospace research. The majority of this money will, of course, be spent within Europe, however, €355 million has been approved for international partnerships in a variety of research and development projects. By sitting at the table Canadians benefit either directly from these resources or by way of spillover benefits through membership in European projects.

Another European project is the €3.25 billion Galileo Satellite Program. Galileo is one of three major satellite global positioning and navigation satellite programs, the others being the US's Global Positioning System (GPS) and Russia's GLONASS. When fully functioning, the plan is for Galileo will be interoperable with these other satellites. The plan is for Galileo to be up and running in late 2005 or early 2006. Another key aspect of the plan is to set up a private operating company for the satellite

Canadian involvement in the program is organized through the Canadian Space Agency membership of the European Space Agency (ESA). To this point, Canada has been involved in the definition phase of Galileo and this has cost $11 million via a CSA contribution to ESA. A decision is pending on Canada's involvement in the development and validation phase of the project, which would call for an addition $19 million investment.

The Galileo program differs from other government-to-government pay-to-play in that it offers the highest level of guarantee that Canadian organizations will be provided work in relation to the CSA's contribution. In this sense, it is the form of pay-to-play that probably offers the least risk to individual participants as it is effectively a joint government-funded development program for government-owned infrastructure. Even in the deployment phase, only 10 per cent of the project will be sold to private interests. The main private sector involvement will come through a process of letting concessions. Presumably the value of these concessions will be priced on the open market to the expectation of their future cash flow. To be sure development participants must compete for their share of the financing, but they do not assume the same level of risk as with commercial pay-to-play or as they do in the Joint Strike Fighter program.

4. Assessment

There is little doubt that pay-to-play is becoming the new paradigm for the development of major platforms in aerospace. As far as autos is involved, there is some question as to whether this is genuine pay-to-play or rather a natural evolution of OEM-supplier relationships. There is a grey area here that relates to the extent to which the sub-supplier has to make significant investments that pay off in the distant future.

Pay-to-play is sufficiently new that it is very difficult to assess whether it has actually paid benefits to the companies that are involved in these types of relationships. In as much as companies continued to enter into these arrangements through the 1990's it is possible to surmise that they saw benefit in doing so. Indeed, pay-to-play is merely one aspect of a myriad of factors that go into determining the relationship between an OEM and its sub-suppliers. For instance, we found that the financial transfer to support common compliance costs was a not a *fait accompli* but rather was merely one factor in complex joint development negotiations.

In this sense, pay-to-play has to be viewed in light of the entire relationship between OEM and lower tier suppliers. Any systems integrator's annual report shows a wide range of OEM-supplier relationship including joint quality programs and long-term exclusive agreements. These have the effect of integrating the operations, and fortunes, of OEM and supplier, probably because it made sense to both parties.

The Management of Risk

Although much is made of how pay-to-play arrangements redistribute risk, in many ways they also mitigate risk. As with other arrangements that tie suppliers closer together, pay-to-play arrangements are a way for lower tier suppliers to reduce competition. This is because pay-to-play arrangements effectively increase the cost of the OEM switching suppliers. So the pay-to-play arrangement acts as a sort of barrier to entry. These barriers are already formidable at the 1st and 2nd tier because of the presence of increasing returns to scale and intellectual property protection. In this sense, the pay-to-play arrangement has the effective of trickling down the OEMs oligopolistic structure to the next tier.

Just because an industry is oligopolistic doesn't mean that it avoids risk. In the view of at least one interviewee, the large commercial aircraft and business jet markets are in serious overcapacity that may take several years to work through. After an unprecedented growth in the 1990's, the market has changed from a producers' market to a buyers' market. This has benefited leasing companies to the detriment of OEMs.

One area that will continue to experience growth is defense spending, particularly in the United States. US and European OEMs have traditionally combined defence and commercial activities to manage business cycle risk. Canadian companies have typically relied heavily on commercial aviation and therefore have not had the cushion of defence contracts to ride out cyclical downturns in the market. In this sense, programs like the Joint Strike Fighter may potentially help Canadian companies manage their commercial risk, if they are able to secure orders (there are no guarantees).

In general, the thrust of government-to-government pay-to-play is to allow Canadian companies to leverage their capabilities into larger projects. This can be considered as a way of achieving scale that would not exist in the absence of a pay-to-play program. Achievement of a larger scale may potentially allieviate market risk. But market risk continues to exist, even for the largest producers. How does a Boeing control the commercial air market or a Northrop Grumman control a Peace Dividend? Even very large companies have to manage market risk and they often do so by developing counter-cyclical products.

Government Support for Pay-to-Play

Part of the reason why pay-to-play is of interest at this time is because of industry calls for enhanced assistance along the lines of the now-defuncted Defence Industry Productivity Program (DIPP). Although the DIPP has been replace by a Technology Partnerships Canada (TPC) program, this program is significantly smaller and more restrictive than its predecessor. As such, both the aerospace industry and the auto sector want to see expansions in TPC and government pay-to-play programs.

At this juncture, it is very difficult to say whether the evolution of pay-to-play demands an enhanced government assistance role. Clearly the practice is of most relevance in the relationship between OEMs and second tier suppliers. Most of these suppliers already have achieved significant scale and are often subsidiaries of foreign multinationals. Presumably these companies are capable of evaluating the potential risks and returns associated with these arrangements and choose those that are of the greatest interest to them.

To repeat, pay-to-play arrangements have the potential to be very lucrative for systems integrators and, inasmuch as they raise barriers to entry, potentially increase the value of these companies. Certainly commercial risks will always remain. But these are large companies that know how to manage risk.

There are several types of arguments that are made in support of government support for pay-to-play. Since systems integrators are largely foreign-owned, an argument goes, Canadian subsidiaries will not win world product mandates unless there is a mechanism to support platform development. But several interviewees pointed out that the expertise of Canadian firms is sufficiently deep that they are quite capable of competing for world product mandates based on

their own competencies. Obviously the ability to bring free money to the table helps, especially if other countries are providing their firms with this money. But unless the government wants to fund the industry on a very significant basis, the financing part of the deal is likely to be marginal to Canadian success.

Another argument is that pay-to-play will have disastrous implications for 3rd and 4th tier suppliers and therefore destroy jobs. Although there is anecdotal evidence that systems integrators are attempting to mimic OEMs by working with fewer suppliers, it is by no way clear that this is a widespread phenomenon. The most recent data suggests that the greatest number of aerospace manufacturers are build-to-print and this seems unlikely to change in the immediate future. In the longer term, there will be mergers and acquisitions as the industry seeks the optimal mix between economies of scale and scope and as it deals with its current excess capacity. The idea that the government can shape the structure of the industry is foolhardy.

A more reasonable argument relates to possible gaps in Canada's research and development framework. The thrust of government policy in recent years has been to put significantly more money into university-based fundamental research. This is effectively a gamble that the government is making on behalf of the taxpayers. The only thing that matters to Canadian living standards is the extent to which this investment finds its way into innovations (preferably patentable ones that are owned by Canadians) that are used to produce goods in Canada. Obviously unless fundamental research is linked to a development phase, these types of benefits are unlikely to be realized and the government investment in fundamental research will pay poor returns to Canadians.

Given the track record of Canadian universities, there is certainly a case to be made that Canada could improve its linkages between university research and platform development. But the new research money being provided to universities makes only a vague commitment to make these connections.[6] Certainly universities can, on their own account, seek out linkages with industry that will define the next generation aerospace and auto technologies. But as one interviewee suggested, there are few incentives in the current system for them to do so.

As such, with significant new money being put into fundamental research, the distribution of funds across the research and development spectrum may end up being too heavily weighted toward fundamental research and not enough to platform development.

Whatever the government does, the underlying risks associated with platform development do not go away, they merely get distributed differently. When it chooses to intervene, the government acts as a sort of mutual fund company on behalf of Canadian taxpayers. In a pay-to-play arrangement, the OEM has already decided to share risk and the taxpayer now takes on a portion of this risk.

This raises the issue of which risks to take. By definition the risks exceed the commercial risk that companies who are best able to evaluate the risk are willing to take. This does not mean that they are bad risks but it certainly means that, at the margin, the taxpayer is likely to assume the most risky parts of the investment.

These public investments may actually produce a return to taxpayers to the extent that they can lay claim to a portion of the resulting cash flow. Understandably industry advocates suggests that this occurs through the tax base in the form of greater corporate and personal income taxes. But a deal where the taxpayer gets to assume the greatest risk and the organization gets to return to society through the tax system is the kind of deal that a systems integrator would never agree to in its negotiations with an OEM.

Options

If the government is going to support company-to-company platform development, it makes the most sense for it to go as far as it can to align its risk with its return. Obviously the companies would not be interested in such an arrangement, which would effectively replicate what private capital markets already do. A second best solution is to provide a generalized tax preference like the research and development tax credit, which has been shown to be one of the industrialized world's most generous tax preferences. A third best solution is to rely on programs like Technology Partnership Canada, which at least attempt to recoup the capital through a loan arrangement.

The other option is to do more government-to-government pay-to-play as the opportunities arise. Programs like the Joint Strike Fighter program seem to offer a very significant amount of leverage and have the additional virtue of diversifying the aerospace industry towards defence applications. Moreover although Canada's involvement is not positioned as part of our commitment to defence, there is no reason why Canada cannot use increased defence spending in cooperation with our allies as a basis for improving Canada's defence industry. At least in this case the rationale for government involvement could be justified on a pure public good basis.

Canada's participation in European programs like Galileo and the Sixth Framework lie somewhere in between the other types. If viewed as a commitment to fundamental research then they are more like a pure public good. But when considered from a commercial point of view, the same arguments around efficiency and equity apply.

For Further Research

This study has been designed to provide an overview of the concept of pay-to-play and its possible implications. Although the study has provided some initial

assessment of the public policy implications, it is beyond its scope to provide a detailed assessment of these issues.

Given the long gestation periods for pay-to-play investments and the relatively recent experience with these arrangements, a definitive determination of the efficacy of pay-to-play is premature at this time. In the future, research in this area might focus on specific pay-to-play deals and whether these have, in fact, been successful in generating the anticipated cash flows to Canadian companies. Similarly, the success of existing government-to-government pay-to-play and support for company-to-company pay-to-play should be considered before committing significantly more resources to these programs. Finally, it is important to do monitor the impact on the 3rd and 4th tiers which, at the present time, appears to be marginal.

Appendix A: People Interviewed for This Study

Allan Martel	President Allan Martel Consulting
Keith Meredith	President Aero insight
Roger Wright	Consultant
Ken Laver	President Messier-Dowty Inc.
Jean-Louis Larmor	Thales International
Brian Sundue	Senior Sector Development Officer (Automotive) Industry Canada
Stephane Lessard,	Head International Relations Canadian Space Agency
Darlene Delaney	Industry Canada
Lucie Boilie	Industry Canada
Jeff Rochon	Industry Canada
Charles Hall	Industry Canada
Rod Jones	Executive Director Ontario Aerospace Council
Peter Boag	Vice President Strategic Planning and Communications Air Industries Association of Canada (AIAC)

References

Aerospace Industries Association of Canada (AIAC). 2001. Aerospace – Meeting Canada's Innovation Challenge. Internet. http://www.aiac.ca/about/IssueAlerts/pdf/InnovationEg.pdf

Aerospace Industries Association of Canada (AIAC). 2002. "Canadian Aerospace Industry Performance – 2001". Internet. http://www.aiac.ca/sitesearch/industry/industryfacts_figures.html

Air Transport Association of Canada (ATAC) Canadian Aviation Maintenance Council (CAMC) and Aerospace Industry Association of Canada (AIAC). 2002. *A Human Resources Study of the Canadian Aviation Manufacturing and Maintenance Industry*. (Ottawa: CAMC).

Auto Parts Manufacturers Association (APMA). 2002. *Blueprint for Canadian Automotive Prosperity*. APMA: Toronto.

Apostolakis, Bobby. 1993. "A Theoretical Exposition of Export and R&D Subsidies" *Rivista Internazionale di Scienze Economiche e Commerciali*. Volume 40. Number 5.

Bagwell, Kyle and Robert W. Staiger. 1994. "The Sensitivity of Strategic and Corrective R&D Policy in Oligopolistic Industries" *Journal of International Economics*. Volume 36.

Butler, A. and S.K. Mitchell. 1998. "Government Subsidies of R&D in a Product Cycle Framework: US-Japan Simulations" *Review of International Economics*. Volume 6. Number 3.

Canadian Press Newswire. 2001. "Auto workers union asks Ottawa for Money to Save Windsor Van Plant" Windsor Star. January 31.

Cassiman, Bruno. 2000. "Research Joint Ventures and Optimal R&D Policy with Asymmetric Information" *International Journal of Industrial Organization*. Volume 18. Number 2.

Cheng, Leonard K. 1987. "Optimal Trade and Technology Policies: Dynamic Linkages" International Economics Review. Volume 28.

Coe, D.T. and E. Helpman. 1995. "International R&D Spillovers" *European Economic Review*. Volume 39.

Conference Board of Canada. *Investing in Innovation: 3rd Annual Innovation Report.* Ottawa: The Conference Board of Canada) 2001.

Economic Council of Canada. "Government Incentive Programs in Canada: Are They an Effective Tool in Stimulating Investment in Productive Plant and Equipment" – Background Paper to the Sixteenth Annual Review. (Ottawa: ECC).

Government of Canada. 2002. Sector Reports: The Canadian Space Industry - The Essence of Innovation. Internet. http://www.innovationstrategy.gc.ca/cmb/innovation.nsf/SectorReports/CanadianSpaceIndustry

Government of Ontario. 2003. Ontario's Auto Strategy. (March 20) http://www.premier.gov.on.ca /english/news/Auto022603_bd1.asp

Fattori, Lisa. 1999. "Canada's aerospace industries collaborate with program to help global competition: AIAC and NRC program unites companies in pre-competitive technology research" Silicon Valley North. Volume 3. Number 5.

Goldratt, Eliyahu M. and Jeff Cox. 1984. *The Goal: A Process of Ongoing Improvement*. (Great Barrington: North River Press).

Goldratt, Eliyahu M.. 1994. *It's Not Luck*. (Great Barrington: North River Press).

Gotz, Georg. 2000. "Strategic Timing of Adoption of New Technologies Under Uncertainty: A Note" *International Journal of Industrial Organization*. Volume 18. Number 2.

Handberg, Roger. 1995. *The Future of the Space Industry: Private Enterprise and Public Policy*. (Westport, Connecticut: Quorum Books).

Hoppe, Heidrun C. 2000. "Second-mover Advantages in the Strategic Adoption of New Technology Under Uncertainty" *International Journal of Industrial Organization*. Volume 18. Number 2.

Industry Canada (Aerospace and Automotive Branch). 2000. Canada's Aerospace & Defence Technology Framework. (Ottawa: Queen's Printer). Internet. http://strategis.ic.gc.ca/pics/ad/framework_eng.pdf

Industry Canada (Canadian Aircraft Design, Manufacturing and Repair Overhaul). 1996. Technology Roadmap (Ontario Pilot Project).

"Is GM Softening on Pay-to-Play Policy?" *Ward's Auto World*, Dec 1, 1998.

Klette, Tor Jakob, Jarle Moen and Zvi Griliches. 1999. "Do Subsidies to Commercial R&D Reduce Market Failures? Microeconomic Evaluation Studies" *National Bureau of Economic Research Working Paper*. Number 6947.

Lawrence, Philip K. 2001. *Aerospace Strategic Trade: How the U.S. Subsidizes the Large Commercial Aircraft Industry*. (Burlington: Ashgate).

Lonmo, Charlene and Frances Anderson. Statistics Canada (Science, Innovation and Electronic Information Division). 2003. *A Comparison of International R&D Performance: An Analysis of Countries That Have Significantly Increased Their GERD/GDP Ratios During the Period 1989-1999*. Cat. 88F0006XIE2003001. (Ottawa: Statistics Canada).

Malatest and Associates Ltd. 2001.*Final Survey Report Vol.2.2.. Canadian Aerospace Labour Market Survey and Employment Forecast, 2001-2004*. Prepared for CAMAQ, OAC and MAHRCC. August.

Ontario Aerospace Ministerial Advisory Committee. 1994. Ontario Aerospace Strategy: Ontario Aerospace: People, Technology, Global Leadership.

Petit, Maria-Luisa. 2000. "Endogenous R&D and Foreign Direct Investment in International Oligopolies" International Journal of Industrial Organization. Volume 18, Number 2.

Pinelli, Thomas E., et al. 1997. Knowledge and Diffusion in the U.S. Aerospace Industry: Managing Knowledge for Competitive Advantage.

Poterba, James M. (ed.). Board on Science, Technology, and Economic Policy. 1997. Borderline Case: international tax policy, corporate research and development, and investment. (Washington, D.C.: National Academy Press).

Qiu, Larry D. 1998. Policy on International R&D Cooperation: Subsidy or Tax? European Economic Review. Volume 42. Number 9.

Rosa, Julio Miguel. Statistics Canada (Science, Innovation and Electronic Information Division). 2002. Determinants of Product and Process Innovation in Canada's Dynamic Service Industries. Cat. 88F0006XIE2002017. (Ottawa: Statistics Canada).

Shah, Anwar. 1995. “Research and Development Investment, Industrial Structure, Economic Performance, and Tax Policies” Fiscal Incentives for Investment and Innovation. (Oxford: Oxford University Press for the World Bank).

Silcoff, Sean. 2003. “Landry willing to backstop Bombardier: Loan guarantees: Premier promises as much as $3-billion if necessary” Financial Post (National Post). January 22.

Statistics Canada (Science, Innovation and Electronic Information Division). 2002. Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1991 to 2002, and by Province 1991 to 2000. Canada. Cat. 88F0006XIE2002015. (Ottawa: Statistics Canada).

Statistics Canada (Science, Innovation and Electronic Information Division). 2002. Provincial distribution of federal expenditures and personnel on science and technology, 1991-92 to 1999-2000. Cat. 88F0006XIE2002008. (Ottawa: Statistics Canada).

Statistics Canada (Science, Innovation and Electronic Information Division). 2002. Survey of Innovation 1999, statistical tables. Manufacturing industries, Canada. Cat. 88F0006XIE2002016. (Ottawa: Statistics Canada).

“Subsidy cut trims aerospace sales: aerospace R&D sector threatened by slashing of Defence Industry Productivity Program” Financial Post Daily. March 22, 1995.

Yi, Sang-Seung and Hyukseung Shin. 2000. “Endogenous formation of research coalitions with spillovers” International Journal of Industrial Organization. Volume 18. Number 2.

Wessner, Charles W. (ed.) Board on Science, Technology, and Economic Policy. 2001. The Advanced Technology Program: Assessing Outcomes. (Washington, D.C.: National Academy Press).

Wessner, Charles W. (ed.). Board on Science, Technology, and Economic Policy and National Research Council (Policy and Global Affairs). 1999. The Advanced Technology Program: challenges and opportunities. (Washington, D.C.: National Academy Press).

Endnotes

[1] Government of Ontario. 2003. *Ontario's Auto Strategy*. (March 20) http://www.premier.gov.on.ca /english/news/Auto022603_bd1.asp.
[2] "Is GM Softening on Pay-to-Play Policy?" *Ward's Auto World*, December 1, 1998.
[3] Conference Board of Canada*. Investing in Innovation: 3rd Annual Innovation Report.* Ottawa: The Conference Board of Canada) 2001. Chart 1, p. 8.
[4] See for instance: Eliyahu M. Goldratt, and Jeff Cox. 1984. *The Goal: A Process of Ongoing Improvement*. (Great Barrington: North River Press).
[5] Author's estimate based on: Lonmo, Charlene and Frances Anderson. Statistics Canada (Science, Innovation and Electronic Information Division). 2003. *A Comparison of International R&D Performance: An Analysis of Countries That Have Significantly Increased Their GERD/GDP Ratios During the Period 1989-1999*. Cat. 88F0006XIE2003001. (Ottawa: Statistics Canada). and Conference Board of Canada*. Investing in Innovation: 3rd Annual Innovation Report.* Ottawa: The Conference Board of Canada) 2001.
[6] See for instance: the Framework Agreement Between the Government of Canada and the Association for Canadian Colleges and Universities.