Peat, Marwick and Partners



# THE IMPACT OF CANADA'S SPACE PROGRAM ON THE SPACE INDUSTRY

July 31, 1981

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July 31, 1981

PRIVATE

Mr. B. Grace
Chief, Telecommunications
Electrical and Electronics Branch
Department of Industry, Trade and
Commerce
6th Floor East
235 Queen Street
OTTAWA, Ontario
K1A 0H5

Dear Mr. Grace:

In April, 1981, we were authorized to conduct a study of the impact of Canada's Space Program on the space industry. The attached report presents our findings and our assessment of the space industry's future prospects. Separate appendices present the study's results for each of the firms participating in the study, and a description of the methodology used in the study.

OBJECTIVES

The primary objectives of the study were to:

- Review the financial prospects for Canada's space industry under three scenarios of possible government expenditures on major space programs.
- Assess the social return to Canada from space activities that result under each of the levels of government expenditure.

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## APPROACH

In conducting this study we undertook the following activities:

- A brief review of past government space programs and recent industry performance.
- An analysis of the business forecasts for the major space companies in Canada for the period 1981 to 1990.
- The calculation of the private return on investment anticipated by each company under the three possible scenarios, using discounted cash flow methodology.
- The calculation of the social return to Canada for the industry as a whole under each scenario, taking into account such factors as foreign exchange, labour benefits, and government subsidies, again using discounted cash flow methodology.

Six companies, representing about 80% of total space industry sales, participated in the study. SPAR Aerospace, MacDonald Detwiller and Associates, SED Systems, Com Dev, Canadian Astronautics Limited, and Miller Communications submitted business forecasts. These forecasts formed the basis for the subsequent calculation of the companies' private returns as measured by internal rate of return and the industry's social return as measured by net present value. All analysis was carried out in 1981 constant dollars.

The three scenarios of government expenditure in the period 1981-85 analyzed in the study were as follows:

1. The base case assumed that government would go forward with its currently approved program plus the L-SAT program.
2. The second case assumed that in addition to the above expenditures, government would go ahead with the RADAR-SAT program, thus there would be two major satellite programs started in the period 1981-85.

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3. The third case assumed that three satellite programs would start in the period. These programs would be either the mobile satellite system (M-SAT) or the direct broadcast system (DBS) in addition to L-SAT and RADAR-SAT.

CONCLUSIONS

Since 1975, Canada's space industry has grown very rapidly. The results of our analysis indicate that the companies expect that they will continue to prosper over the next ten years. The rates of return predicted by the companies ranged from about 20% to 80%, with an industry average of 30% to 50% depending on the scenario for government expenditures. These rates measure return on investment before interest and taxes, and are not representative of the companies' net profitability.

If government undertakes three major satellite systems in the next five years, industry expects to perform considerably better than under the other scenarios. This is largely due to the production efficiencies and economies anticipated by the industry with three major programs under construction in the next five years. These efficiencies would then permit the companies to expand their foreign markets.

The social returns to the nation as a whole, after adjusting the companies' private returns for factors such as foreign exchange premium, the social opportunity cost of labour, and government subsidies, grants, and other industry support programs, were also substantial. These returns indicate that the country as a whole should expect to benefit from the space industry. Moreover, these benefits would become even larger if additional major space programs were undertaken in Canada.

The social returns, as estimated in the study, furthermore indicate that government could pay a premium on its purchases from Canadian industry and still anticipate a net social benefit to the economy. The likely amount of

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any premium is difficult to estimate with any certainty. However, according to the study's estimates, a premium of as much as 20% under the second case (that is, for two major space programs) and 30% under the third case (that is, for three major programs) could be justified in the basis of the social benefits to be derived from undertaking the activity in Canada.

It must be pointed out that the study's results are dependent on certain key assumptions which could eventually prove to be unrealistic. The most important of these are the following:

- The calculations of the private rate of return and the social return are based on forecasts prepared by the firms and therefore could be subject to an upward bias on the part of the participating companies.
- Assumptions used to adjust private returns for social costs and benefits are based upon the best available empirical evidence. They, nevertheless, could be dated and subject to judgment in their application to the space industry.
- Purchases by government are assumed to represent legitimate needs on the part of government and are justified on their own merits.
- It is further assumed that if government did not purchase from Canadian sources it would have purchased from foreign sources.
- No premium is explicitly assumed on the price paid by government on its purchases from Canadian sources. Past experience, nevertheless, indicates that some premium is likely.

It should be futher noted that it is not possible to capture all the costs and benefits related to the space industry. We have not, for example, included the cost of government space program administration, services such as those provided by Trade Commissioners, export off-sets and special export credits on foreign sales and any significant assistance to overcome loading difficulties that industry may face if major space programs do not materialize. Nor have we included the benefits of industrial spin-offs into non-space areas and non-quantifiable benefits such as national security in the study's analysis.

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We would like to acknowledge the excellent cooperation received from the six firms participating in the study. We are also grateful for the assistance provided by officials in the Department of Industry, Trade and Commerce, the Department of Communications, Energy, Mines and Resources Canada, the Department of National Defence, the Ministry of State for Science and Technology, Treasury Board, and the National Research Council of Canada in carrying out this study.

Yours very truly,

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INDUSTRY, TRADE AND COMMERCE

ELECTRICAL AND ELECTRONICS BRANCH

# THE IMPACT OF CANADA'S SPACE PROGRAM ON THE SPACE INDUSTRY

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## EXECUTIVE SUMMARY

The effects of Canada's Space Program on Canadian industry are demonstrated in this study. Since as early as 1959, government expenditures in space have stimulated the establishment of an indigenous industry. However, it was not until the early 1970's that government policies, intent on creating an environment in which domestic industry could benefit from the nation's space program, took effect.

### Past Developments

By 1981, the results of those policies are evident. The Canadian space industry has achieved an average sales growth rate of over 35% in the period 1975 to 1980 with sales reaching over $140 million. The majority of these sales are to foreign customers, largely the major satellite systems companies in the United States. Canadian firms have pioneered technologies in a number of important areas such as remote manipulator systems, remote sensing, search and rescue, and high frequency satellites which they hope to export to international markets. Furthermore, Canadian firms produce satellite components and subsystems which, because of their reliability, quality and price, are found in satellite systems in most western industrialized countries.

Government programs to transfer technology to industry, to take on the risks of first buyer, and to support company research and development efforts and capital expansion have been critical, in many cases, to the success of Canadian firms. A number of well-documented cases of government assistance can be cited. Several examples are contained in the study.

Despite its rapid growth and success in penetrating export markets, Canadian industry has certain weaknesses. It is still too small to undertake on its own the R&D efforts necessary to keep at the fore of technological developments. Moreover, the long period of gestation before a product, first developed as a prototype for specialized civil or military uses, can be introduced to commercial clients, means that the firms may have to endure long periods of negative cash flows. Unless other kinds of business or products can generate adequate returns, the company could probably not sustain that product's development.

In order to penetrate foreign markets, companies need to have demonstrated the success of their products. Space investments are too costly for most clients to run the risk of using a new product if a reliable source is available elsewhere. Since firms cannot prove their products on their own, government can continue to play the key role of the first buyer. Furthermore, since most space business has strong political overtones and involves government-to-government relations, support by way of international agreements and contracts will also continue to be important.

Industry has yet to prove its capabilities to undertake entire satellite systems. SPAR, as prime contractor for Anik-D, is developing those skills which it hopes to expand and deepen with its involvement in ESA's L-SAT program.

Market Prospects

The overall prospects for Canadian industry look encouraging. Market surveys, like that done by the Department of Industry, Trade and Commerce in 1980, point to an expanding market as more developing nations embark on domestic satellite communication systems of their own, and the developed nations apply satellites in voice communications, data transmission, teleconferencing, direct broadcast and remote sensing. In fact, the potential demand for satellites is expected to be near saturation in certain areas. These demands are also the precursor of mass markets developing for low-cost ground equipment. The renewed emphasis on improved defence capabilities among NATO members and in the United States particularly will also result in sizeable markets for highly sophisticated communications, remote sensing, and surveillance equipment.

These space markets, however, are unique and it is not easy to translate global opportunities into sales for individual firms. Much of the international market is closed to foreign companies for national security and political reasons. It is highly competitive, with European governments providing extraordinary assistance to their national industries in order to win major prime contracts. Moreover, American firms appear well entrenched in their positions as world leaders in the industry. Canadian firms have to be technologically superior and strongly marketing-oriented in order to compete successfully.

## Canada's Space Program

Canada's space program has been of considerable benefit to domestic industry in the past, and it is anticipated that the future space program will hold promise of similar opportunities for Canadian companies. Although the current program, amounting to some $260 million over the next three years, represents a decline in real terms since the peak of government expenditures achieved in the late 1970's, there are a number of major satellite programs now under study that will likely lead to sizeable contracts for industry in the coming years. These programs include the L-SAT, RADAR-SAT, M-SAT and DBS satellite systems.

In order to assess the impact that these major programs might have on Canadian industry and to estimate the social returns to Canada on government investment in space, six companies, representing an estimated 80% of total industry sales, were asked to provide projections of their sales and financial results for the period 1981 to 1990, under three different assumptions for the government's space program. The first scenario had the government undertaking in the 1981-86 period only the L-SAT program. The next scenario had L-SAT plus RADAR-SAT, and the final scenario had three major satellite programs (L-SAT, RADAR-SAT, plus either M-SAT or DBS). The firms were also asked to provide details on their sales composition, their foreign exchange utilization, investment plans, demand for labour and marketing strategies.

The firms participating in the study were SPAR Aerospace, MacDonald, Dettwiler & Associates, SED Systems, Com Dev, Canadian Astronautics Limited and Miller Communications Systems.

Not all the companies foresaw the prospects for their performance differing under the three scenarios. Hence, MDA prepared forecasts for only two cases, while Miller and SED Systems prepared only one forecast each. SPAR, Com Dev and CAL each provided sufficient information for the three scenarios.

## Industry Forecasts

The forecasts which were prepared by the six firms indicate that the firms are anticipating continued rapid growth in their businesses. Total sales are predicted to increase by 17 to 22% annually. Depending on the scenario, sales will reach from $439.8 to $675.3 million (1981 $) by 1990. Export performance improves, with firms predicting that exports by 1990 would account for over 60% of sales. In addition, substantial amounts would be committed to R&D activities. Under the high scenario (that is, three government satellite programs) industry performance is predicted to be considerably better by most measures than under the other scenarios. Nevertheless, even the low scenario (that is, only L-SAT) represents a case of satisfactory industry performance.

## Return on Investment

The information provided by the companies enabled us to calculate the internal rate of return (IRR) on the cash flows[1] generated by the company under each scenario. This calculation was made prior to any adjustments for economic distortions and, hence, constituted a measure of the private return on investment enjoyed by the companies.

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[1] Before taxes, interest, and depreciation.

The same figures formed the basis for the calculation of the company's social returns as measured by net present value (NPV). Adjustments were made to the private cash flows to reflect the cost and benefit to the economy for the use of foreign exchange, employment, sales tax foregone, and government subsidies and grants. Certain government expenditures, for example goverment's contribution to ESA, benefit the industry as a whole and therefore were included as adjustments to the aggregate returns and not attributed to individual companies.

The above analysis resulted in the calculation of the space industry's return by company and the social return for the industry as a whole. All results are in 1981 constant dollars.

## Private Returns

Based on the projections provided by the six companies, the companies expect significant private returns on their space-related business. Internal rates of return vary from 22 percent to 83 percent. One exception to a positive IRR occurred with one company under the second scenario (that is, with RADAR-SAT). In that instance, the company anticipated making significant expenditures in R&D and, given the long period before commercialization of the RADAR-SAT technologies, it did not expect to recoup those expenses in the timeframe of the study.

The high private returns forecast by the firms reflect the low capital base of most companies in the space industry. Firms, particularly CAL and Miller, do substantial amounts of non-manufacturing work (studies, systems design, etc.) that does not require much investment. Others (SED Systems, SPAR, Com Dev) are more geared towards commercial production and hence have relatively high investments. Nevertheless, as a whole, the industry does not require substantial capital investment and therefore generates very high sales and profits per unit of capital invested.

The differences between the cases, where applicable, point out that the industry would benefit from additional government programs. Again, except for the one company with RADAR-SAT, the anticipated returns increase if new programs are added. As prime contractor, SPAR particularly benefits from the enlarged government program: its IRR increases from 36% to 70% from the base case to the case with three major programs.

Social Returns

With the one exception under the second case, all of the companies generate a positive NPV after adjustment for the social costs and benefits attributed to their space activities. The NPV of the base case (only L-SAT) is estimated at $89.9 million, the NPV for the second case (L-SAT and RADAR-SAT) increases by $32.5 million to $122.4 million, and the NPV for the third case amounts to $213.6 million. This sizeable increase is largely attributable to SPAR's forecasts under the third scenario. SPAR expects to achieve greater operational economies and high efficiency if three major programs are undertaken and therefore expects to be able to penetrate new markets, particularly with US defence contractors. It should be noted that the above figures assume that there is no premium paid by government on its purchases from Canadian sources.

Nevertheless, the high social return on investment indicates that the economy as a whole can still benefit from the nation's space program even if Canadian industry required subsidies by way of a premium on purchases from Canadian sources in order to undertake specific satellite programs. The effects of paying a premium in Canadian purchases for RADAR-SAT and M-SAT (or DBS) are as follows:

- The incremental economic impact of undertaking the RADAR-SAT program is $32.5 million (1981 $) if no purchase price premium is expected for procuring the system domestically. If a purchase price premium of 10, 20 or 30 per cent is expected, the incremental impact declines to $19.8 million, $7.1 million and negative $5.6 million respectively.

- The incremental economic impact of undertaking the RADAR-SAT and M-SAT programs together is $91.2 million (1981 $) assuming no purchase price premium. If a premium on the two systems of 10, 20 or 30 per cent is assumed, the incremental economic impact declines to $67.3, $43.4 or $19.6 million respectively.

Thus, the industry's overall economic benefits can sustain a premium up to 20 per cent for the RADAR-SAT alone or up to 30 per cent for the two systems in combination. The superior performance of the two systems together results from the expected industrial and technological synergism of having two such high technology projects in addition to L-SAT undertaken in the period under review.

Sensitivity

The above assessment of the industrial impact of Canada's space program is based on a number of key assumptions which can profoundly affect the results of our analysis. It is therefore important to recognize the sensitivity of these results to their underlying assumptions when interpreting and using the above figures. The critical assumptions are as follows:

- The results are derived from forecasts prepared or material provided by the firms. Since the projections go to 1990, there will, no doubt, be considerable margins of error. Furthermore, it was impossible to verify the data provided by the firms or to do an independent market assessment of each firm. We did, nervertheless, review the forecasts for reasonableness and internal consistency and compare the forecasts with past results. The forecasts, however, may still be optimistic in certain cases.

- The company projections assume rapid starts on the major space programs so that no additional government support was predicted to sustain particular capabilities. Thus, no significant assistance to overcome industrial loading problems was included in the analysis.

- The social benefits accruing to the space industry were highly dependent on the estimated premiums attached to foreign exchange and to employment. Counter-arguments could be put forth that the estimated foreign exchange premium of 15% is too high, that domestic sales are not entirely import replacements, and that highly skilled labour in the space industry has an opportunity value greater than 90% of the actual wage bill. The assumptions used in the study may tend to overstate the real social benefits.

- In estimating the social costs of government's support to the space industry, assumptions were made as to whether specific government programs were in fact subsidies to the industry or, alternatively, whether they represented purchases of goods and services needed by government that would proceed on their own merits. Subjective criteria were applied, after discussion with government officials, to make the distinction among government programs. Again, the tendency was to favour industry, since government purchases as a general rule were assumed to satisfy real needs by government.

- No purchase price premium was explicitly assumed on government purchases in general. We know from past experience that such premiums may be required. Our analysis indicates that the industry's social returns could justify a purchase premium on the major satellite programs. No analysis, however, was made on the possibility of premiums on other government purchases besides these major programs.

- Not all the social costs of the space industry are likely to have been captured in the adjustments made in the analysis. For example, the cost of program administration by government departments and the cost of government services, not specifically related to space like the Trade Commissioner service for export advice, were not included. Moreover, the analysis did not include the costs of trade off-sets and special export credit that could arise in space export sales.

## Non-Quantified Benefits

A potentially important consideration in assessing the impact of Canada's space program on industry is technological spin-offs into non-space related areas. The analysis carried out in the study did not explicitly take into account the potential sales by the six companies of products developed as part of their space efforts but whose applications spread outside the space field. We know that these sales do in fact occur: one example is cited in the report. However, it was not possible to estimate such benefits and attribute their origins specifically to the firms' space activities. The return on investment calculation in the study, as a result, understates real returns since it ignores any spin-offs.

Other non-quantifiable benefits exist in terms of national security, international relations, and national pride that result because of Canada's space program. These benefits are typically non-economic and were also not covered in this study. However, we expect that in making policy decisions with regard to future space activities, government would take such factors into account.

# I - INTRODUCTION

The Canadian government began efforts to develop an indigenous space industry as early as 1959. During the 1960's the government initiated a series of experimental and demonstrational programs in which Canadian industrial participation increased steadily. Since 1969, government spending under contract with Canadian space companies has amounted to $250 million. In addition, $187 million has been contributed directly to industrial development through a variety of programs. A major aim of this assistance has been the creation of a domestic prime contractor capability.

A study entitled The Canadian Space Industry, Preliminary Report, Options for the 80's prepared for the Department of Industry, Trade and Commerce in 1980 indicated that the seven leading companies were predicting a 21 per cent annual growth rate and were planning to commit large amounts of money to capital investment and research and development. These predictions were, however, based on a variety of different assumptions including assumptions regarding government plans and policies.

## STUDY OBJECTIVES

The objective of this report is to assess the future prospects for the performance of the industry under given assumptions regarding government procurement. This assessment of future prospects has two major components:

- a general review of the financial prospects for the major firms under each of three possible levels of government expenditure.
- an assessment of the social rate of return to Canada from the space industry that results from each of the three levels of government expenditure.

It is hoped that this information will facilitate the decision-making process with respect to future government policies towards the space industry.

SCOPE AND METHODOLOGY

In conducting our review of the industry, we concentrated in the six leading companies:

- SPAR Aerospace Limited
- SED Systems Inc.
- MacDonald, Dettwiler and Associates
- Canadian Astronautics Ltd.
- Com Dev Ltd.
- Miller Communications Systems Ltd.

These companies account for about 80 per cent of industry sales. Each company was visited at least once and generally twice. Special attention was paid to SPAR Aerospace which accounts for approximately 60 per cent of industry sales. Discussions were held with senior executives from each of the companies as well as with a variety of government officials and industry experts.

An assessment of the potential social return entails obtaining forecasts of the future sales of the industry under each possible level of government expenditure, estimating future profitability, and calculating the private rate of return to the companies involved in the space industry. This private rate of return is then adjusted to take into account the externalities which directly affect the national interest but which do not directly affect the financial statements of the companies. These include such items as foreign exchange generated and employment created. The overall benefits of investing resources in the space industry are then compared to the opportunity cost of capital.

The results of such a review are heavily dependent upon the market forecast for the industry over the next decade. As indicated in our terms of reference, we have not conducted an independent review of the market prospects either for the industry as a whole or for the individual companies. We have relied upon the forecasts prepared by the individual companies. These have been discussed with the companies and with knowledgeable government officials to ensure consistency and reasonableness.

## Definition of the Industry

We have, in general, used the industry definition contained in The Canadian Space Industry, Preliminary Report, Options for the 80's. Each of the six companies was asked to separate their business into space and non-space segments. Only that portion of company sales classified as space or space-related has been included in the analysis.

Our results pertain to the six listed companies only and do not include sales, etc., for the remaining companies in the industry. The results, therefore, represent an investment analysis of the six companies rather than the entire space industry. These companies do, however, account for an estimated 80% of the Canadian space industry.

## STUDY APPROACH

In undertaking this study, we examined the past performance of the industry, including a review of past government policies. The global outlook for the products of the Canadian space industry was assessed and, for each of the six companies, the effects of three different levels of government expenditure on the company's sales and financial performance were analysed. Finally, we calculated the private rate of return achieved by each of the six companies as well as the social return to the nation.

Subsequent sections of this report present our findings, analysis and conclusions. We believe that the results of our review represent an achievable forecast of the future of the Canadian space industry.

# II - PAST PERFORMANCE OF THE INDUSTRY

## THE INDUSTRY'S EVOLUTION

The space industry in Canada is relatively new. Having its genesis in the post-war period, space activity began in earnest only in the late 1950's following the first satellite launch by the USSR. In 1962, Canada became the third nation to launch a satellite.

At that time, Canada's space industry was dominated by foreign-owned subsidiaries that were primarily engaged in assembling equipment designed by their parent companies. These first entrants in the space field were largely aviation and electronics-based companies: typical firms included Bristol, RCA Victor, and Canadian Marconi. SPAR, then part of de Havilland Aircraft, and Northern Electric were among the first Canadian-owned firms to develop space capabilities.

The largest pool of expertise, however, was to be found in government laboratories. In fact, Canada's first satellite was built by the Defence Research Board and the first ground stations by the Department of Transport. Industry's contribution to Alouette I, principally by SPAR and RCA Victor of Montreal, was limited to a few subsystems and components.

By the late 1960's, the focus of Canada's space program shifted from a scientific orientation to domestic communication systems. This shift was reflected in the creation of Telesat in 1969 and resulted in enlarged market opportunities for Canadian industry. Canadian firms undertook the construction of ground stations and continued to supply complex systems for space craft.

It was government's intention that Canadian industry benefit from the nation's space program, as articulated in The Canadian Policy for Space, announced by the Federal Government in 1974. Despite its technological excellence in particular areas, Canadian industry was still fragmented and small. To stimulate the industry's development, government adopted 'make or buy' policies in the early 1970's. It also encouraged the setting up of a prime contractor capability in Canada.

These policies appear to have had a positive effect. Since the early 1970's new Canadian firms have been created, and space-related sales have expanded rapidly. In 1975 total space sales were in the order of $11 million, of which 11% were exports. By 1979, only five years later, total sales had risen to about $140 million, of which 43% were exports. The growing strength of Canada's space industry is further demonstrated in the increased Canadian content of Telesat's satellite procurement: Anik-A had 13%; Anik-B, 21%; Anik-C, 33%; and for Anik-D, about 50% is anticipated.

The structure of the industry has also changed with the consolidation of commercial satellite capabilities under SPAR. In 1977, SPAR acquired a substantial portion of the government and commercial systems division of RCA Ltd. in Montreal and the payload manufacturing capability of Northern Telecom. SPAR now accounts for some 60% of total industry sales. Young, dynamic, Canadian-owned companies plus the space divisions of larger, more diversified, foreign-owned companies account for the balance.

## ROLE OF GOVERNMENT POLICIES AND PROGRAMS

The Canadian government has played a key role in fostering Canada's space industry since the inception of Canada's space program in 1959. The following highlights only some of the ways in which government policies and programs have shaped Canada's industry. More comprehensive discussions of government policies can be found in recent departmental reports and in the study undertaken by Phoenix Associates concurrently with this study.

Technology Transfer

Government laboratories were the first source of space technology which was transferred to industry for exploitation in a wider market.[1] This government did, first, by involving industry in the design and manufacturing of subsystems and by training engineering staff. Later, government encouraged industry through its make-or-buy policy which effectively reduced the amount of research done in government laboratories. The share of government expenditures in industry as a percentage of total government space expenditures has risen from an average of 28% from 1969 to 1974 to 58% from 1975 to 1980. This policy continues, for example, with NRC's joint NASA Space Science Program and with CRC's technology transfer programs.

First Buyer

As one of two domestic buyers of satellite systems, the federal government can have a pervasive influence on the products of Canadian industry. Government has directed over 80% of its industrial contracts to Canadian firms and is the largest purchaser of satellite systems for military use, navigational aids, weather and environmental monitoring, search and rescue, resource management and advancement of scientific knowledge. It has further ensured that an increasing percentage of Telesat's procurement goes to Canadian firms by paying a premium when necessary.

As the first buyer of innovative space products, government can further help industry absorb the risks of new product development and in fact encourage

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[1] Examples of technology transfer in the space sector are presented in a MOSST Background Paper, Technology Transfer by Department of Communications: A Study of Eight Innovations, no. 12, 1980.

EXHIBIT 1

GOVERNMENT INDUSTRIAL ASSISTANCE IN FY 1980/81

($'000)

| | Industrial Contracts Fund* | Grants** IRAP | PILP | DIPP | EDP |
|---|---|---|---|---|---|
| SPAR | 920.4 | - | - | 4,203.0 | - |
| SED Systems | 264.7 | - | - | - | - |
| Miller | 183.1 | - | - | - | 345.0 |
| MDA | - | 211.4 | 383.2 | - | - |
| CAL | 265.6 | - | 78.0 | - | - |
| Com Dev | 113.2 | 162.4 | - | - | - |
| Total | 1,747.0 | 373.8 | 461.2 | 4,203.0 | 345.0 |

*Including SSC Bridge Funding

**Approvals, not actual disbursements

industry to innovate. Examples of government as first buyer include the upgrading of LANDSAT earth stations, the local user terminal for SAR-SAT systems, and the remote-manipulator system for NASA's space shuttle. With the purchase of such prototype equipment, an estimated 30 to 40% of total expenditures by government cover non-recurrent development costs associated with the manufacture of equipment for the first time. Further sales by the manufacturing company are thereby enhanced as these non-recurrent costs need not be recovered.

Common Facilities

Government has made the expanded testing facilities at DOC's David Florida Laboratory accessible to Canada industry. Thus, activities which firms could not undertake on their own can now take place in Canada, thanks to the pooling of government and industry needs for highly specialized equipment.

R&D Support

The high costs and risks inherent in space research make government support for R&D vital. Firms can qualify under government development programs like ITC's Enterprise Development Program, the Defence Industry Productivity Program, NRC's Industrial Research Assistance Program and the Program for Industry/Laboratory Participation. There are also special programs aimed at supporting the space industry such as DOC's Industrial Contract Fund. Furthermore, SSC's unsolicited proposal fund has proven to be a particularly effective and flexible source of R&D funding. On the whole, R&D funds provided by government under these programs have been modest, as shown in Exhibit 1, opposite, yet according to industry, essential to the development of new space products.

## International Cooperation

Since a great deal of space business involves government-to-government dealings, the Government of Canada has the role of intermediary to play in negotiating international agreements. Bilateral and multilateral technological contracts have further opened market opportunities for Canadian companies in both Europe and United States. As a result of Canada becoming an associate member of the European Space Agency (ESA), for example, Canadian firms can now compete for contracts under L-SAT and ESA's remote sensing programs. Joint development with the US and France of the SAR-SAT system has led to sales in both countries. In a more general way, Canada's participation in international agencies that regulate space activities world-wide ensures a voice for Canadian interests in matters such as frequency allocations and orbital assignments.

## Major Government Programs

Since the start of Canada's space program in 1959, the Canadian government has sponsored four satellite systems. In addition, Telesat has undertaken the Anik satellite series, consisting of three Anik-A satellites launched from 1972 to 1975, Anik-B in 1978 and Anik-C and Anik-D to be launched in 1981 and 1982 respectively. Thus, over a twenty-three year period, there will have been some twelve satellites launched, or one satellite launched every two years on average.

Reflecting Canada's thrust to develop a domestic communications system, space activities reached a peak in the early 1970's. At that time, government sponsored the Hermes (CTS) experimental program, and the beginning of the remote sensing program using LANDSAT satellites. Telesat, furthermore, was beginning the Anik series with Anik-A for which Hughes was prime contractor. Canadian industry was particularly active on the earth station side as well as in the design and manufacture of the Hermes satellite.

## EXHIBIT 2

## GOVERNMENT SPACE EXPENDITURES

| Fiscal Year | Total Expenditures ($'Million) | Expenditures in Canadian Industry (%) |
|---|---|---|
| 1969/70 | 15.6 | 28.8 |
| 1970/71 | 13.8 | 32.6 |
| 1971/72 | 24.2 | 20.7 |
| 1972/73 | 33.1 | 31.7 |
| 1973/74 | 34.9 | 28.7 |
| 1974/75 | 34.9 | 45.8 |
| 1975/76 | 40.2 | 47.3 |
| 1976/77 | 46.9 | 53.8 |
| 1977/78 | 65.3 | 69.0 |
| 1978/79 | 95.2 | 74.2 |
| 1979/80 | 71.1 | 58.0 |
| 1980/81 | 81.2 | N.A. |
| TOTAL | 556.4 | |

This burst of activity was followed by a modest levelling off of expenditures until the late 1970's. A new peak in space expenditures was achieved in 1979. As shown in Exhibit 2, opposite, government spending reached $95 million in that year. Telesat further spent some $75 million on capital investments in 1979. Principal government activities consisted of the remote manipulator system (RMS) for NASA's space shuttle (over $110 million), expansion of the David Florida Laboratory ($17.7 million) and lease payments to Telesat for Anik-B ($33.5 million). In addition, government undertook to pay premiums to Telesat for testing on Anik-C ($7.3 million) and for SPAR to act as prime contractor on Anik-D ($22.4 million). At the same time, Telesat continued to expand its terrestrial facilities.

These major programs are now drawing to a close. RMS expenditures will cease in 1982/3, and major expenditures for Anik-C and D should be over in a year or so. Telesat's network of earth stations is also nearly complete. Government's current expenditures are estimated at about $90 million per year on continuing space activities. Without the start of a major satellite program shortly, however, Canadian industry may find that their best business opportunities are to be found outside Canada. Government's current space program and the possible new satellite programs that government is considering are discussed in Chapter IV.

## IMPACT OF GOVERNMENT POLICIES AND PROGRAMS

Over the past decade, the federal government has invested over $500 million in Canada's space sector, more than half of which was spent on contracts with Canadian industry. In addition, Telesat has spent some $300 million on capital investments in a similar period. There can be no doubt that these expenditures stimulated Canadian industry to market new products and to develop new skills and technologies that it would otherwise not have had the opportunity or the resources to undertake.

Government policies have been particularly important to small and medium-sized Canadian-owned firms. These firms have in large part been eager to exploit technologies developed in government laboratories in order to establish their own market niche. They are also responsive to opportunities offered by government to develop new skills and expand their limited product lines.[1] Larger companies, with an already established technological capability, tend to be less likely to show interest in government programs, especially if they do not have obvious potential in commercial markets.

This has been the experience of firms in the study. For example, MacDonald, Dettwiler and Associates (MDA) obtained key government contracts early in the 1970's to modify the Prince Albert Radar Facility to read out LANDSAT data. It thereby established itself as a leader in remote sensing and data handling systems for meteorological, oceanographic and earth resource satellites. Its capabilities have since expanded to include synthetic aperture radar (SAR), as part of the SEASAT project in which Canada participated jointly with the US in 1977. These efforts were also supported by a PILP grant from NRC of $800,000 in 1979/80. MDA thus will be well placed to participate in the development of airborne radar systems such as those for the proposed RADAR-SAT program.

Another good example of government's impact on Canada's space industry is SED Systems. An offshoot of the University of Saskatchewan, SED Systems was the recipient of technologies transferred from CRC. It won a contract in 1978 to produce two development models of low-cost earth terminals (LCET) for direct broadcast uses and subsequently manufactured 100 LCETs. Earlier, SED Systems had acquired the necessary expertise in microwave technology to undertake the LCET development through a DOC contract of $258,000. These contracts enabled SED Systems to position itself in the emerging LCET market which it hopes to exploit at home and abroad.

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1 These conclusions are borne out by the study of eight cases of technology transfer by the Department of Communications for MOSST.

Canadian Astronautics Limited (CAL) provides another example. A young firm, created in 1974, CAL could not afford to make the R&D investments necessary for it to develop the local users' terminal (LUT) for DND's satellite aided search and rescue program. CAL's total sales in 1977 when it started work on the SAR-SAT project amounted to about $400,000. Funding of about $150,000 obtained from SSC as a unsolicited proposal in 1977 enabled CAL to start the original research. Later, government contracts to develop LUT prototypes were won and these led to the manufacture of LUT's for DND, NASA and, more recently, the French government.

Based on CAL's sales projections for further SAR-SAT sales, the original investment by government in the development of the LUT by CAL is expected to yield an adequate return. The internal rate of return on SAR-SAT's LUT is estimated at 15 to 25% depending on the level of future sales.[1] The return would be even higher if the social impact of CAL's export sales and employment effects were taken into account. Similarly, government's support to CAL to develop its battery management system is also expected to yield a high return - at least 25% depending on future sales.

The above cases are only some of the examples of how government support by way of technology transfer, R&D funding, and early buying of new products has had a positive impact on Canadian space industry.[2]

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1 These rates of return are calculated on the assumption that government development contracts and a portion of DND's purchases are actually R&D investment.

2 Other documented examples are contained in the report prepared by the Department of Communications, Space Sector Report on Industry - Oriented Government-Funded Research and Development, January 1981.

## EXHIBIT 3

## SUMMARY OF FINANCIAL PERFORMANCE

| | 1976 | 1977 | 1978 ($'000) | 1979 | 1980 |
|---|---|---|---|---|---|
| Total Sales | 46,422 | 79,103 | 105,807 | 127,527 | 156,949 |
| Net Profit | 1,077 | 947 | 3,374 | 597 | 3,109 |
| Gross Operating Profit* | 3,582 | 5,611 | 8,383 | 9,223 | 9,343 |
| Net R&D Expenses** | 629 | 1,826 | 2,329 | 2,792 | 3,058 |
| Taxes Paid* | 718 | 872 | 1,409 | 1,029 | 335 |
| Total Assets | 17,207 | 30,565 | 43,680 | 57,774 | 80,173 |
| Net Fixed Assets | 3,964 | 7,584 | 9,459 | 13,563 | 20,354 |
| Net Working Capital | 5,041 | 7,193 | 9,372 | 8,332 | 8,200 |
| Capital Expenditures* | 1,105 | 4,073 | 3,178 | 5,830 | 6,261 |
| Shareholders' Equity | 6,661 | 13,041 | 15,703 | 18,049 | 24,315 |

*Excludes CAL

**Excludes CAL and MDA

They also demonstrate that Canada's participation in international cooperative programs can lead to subsequent export sales. Furthermore, the examples studied show that the support granted by government is likely to result in high rates of return on investment.

## INDUSTRY'S PERFORMANCE

The performance of Canada's space industry over the past several years has been very encouraging. As demonstrated by its rapid growth in sales and exports, it is a dynamic industry with demonstrated international competitiveness in particular areas. Canadian firms have been at the fore of technological advances and have been able to exploit these positions in the world market.

The six firms included in the study are estimated to account for about 80% of total space industry sales in Canada. An earlier study entitled The Canadian Space Industry: Options for the 80's by the Department of Industry, Trade and Commerce, examined in depth the capabilities and performance of seven space firms[1] up to 1979. The following updates that analysis of the space industry and provides some additional detail.[2] Exhibit 3, opposite, provides a summary of the financial performance of the six firms from 1976 to 1980. The results for each firm are contained in Appendix A.

### Sales

Sales of the six firms have increased at an impressive rate. The rate of growth in their sales has averaged over 35% per annum since 1976. In the last year, company sales continued to climb, reaching a total of $157 million for the six firms. An estimated 75% of this amount would be space-related.

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1 The six firms included in the study plus Raytheon.

2 The analysis presented here looks at total company performance, not just space-related activities. Since most firms are not exclusively in the space business, the financial indicators described below are representative of consolidated company performance.

## Exports

The companies' export sales have grown at a much faster rate than their total sales. Over the past six years, the rate of growth in exports has averaged about 200% per annum, reaching over 50% of total sales in 1980 from 11% in 1975.

Exports are particularly important for certain of the companies. For example, MDA expects to export 80% of its sales and Com Dev 75% of its sales. SPAR, the largest space company, expects to export 60% of its sales.

Exports tend to be concentrated with Canada's largest trading partner, the United States. The US accounts for 55% of exports while European nations are assumed to account for most of the balance. Most of the exports are to commercial clients, the large American aerospace companies like Hughes, that incorporate Canadian subsystems and components into their satellites.

## Domestic Market

Government and Telesat dominate the domestic market for space products. SPAR, as prime contractor on Anik-D, sells the majority of its products to those two customers, as do CAL and Miller.

## Capital Investment

As the space industry has matured and more of its products evolve from prototypes sold in limited numbers to commercial products sold to customers world-wide, capital investment by the companies has increased.

EXHIBIT 4

KEY INDICATORS

Companies including SPAR

| | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|
| Growth in Sales (%) | - | 70 | 34 | 21 | 23 |
| Net Profit (% of Sales) | 2.3 | 1.2 | 3.2 | 0.5 | 2.0 |
| Net Profit (% of Equity) | 16.2 | 7.3 | 21.5 | 3.3 | 12.8 |
| Gross Operating Profit (% of Sales) | 7.7 | 7.1 | 8.0 | 7.3 | 6.0 |
| Net R&D Expenses (% of Sales) | 1.5 | 2.4 | 2.3 | 2.4 | 2.1 |
| Sales per Net Fixed Assets ($) | 11.7 | 10.4 | 11.2 | 9.4 | 7.7 |
| Growth in Total Assets (%) | - | 78 | 43 | 32 | 39 |
| Growth in Fixed Assets (%) | - | 91 | 25 | 43 | 50 |

Companies excluding SPAR

| | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|
| Growth in Sales (%) | - | (1) | 55 | 34 | 56 |
| Net Profit (% of Sales) | 13 | (0.4) | 8.5 | 7.9 | 5.1 |
| Net Profit (% of Equity) | 11.6 | (60.7) | 64.4 | 44.4 | 17.3 |
| Gross Operating Profit (% of Sales) | 5.6 | 4.8 | 14.2 | 13.4 | 11.6 |
| Net R&D Expenses (% of Sales) | 6.0 | 9.5 | 6.4 | 4.2 | 4.5 |
| Sales per Net Fixed Assets ($) | 11.9 | 6.3 | 8.9 | 7.5 | 5.5 |
| Growth in Total Assets (%) | - | 62 | 50 | 71 | 41 |
| Growth in Fixed Assets (%) | - | 87 | 10 | 60 | 113 |

From 1976 to 1978, capital expenditures for the six firms amounted to only $1.5 million. SPAR, however, has undertaken considerable new investment - over $8.7 million in the last two years - part of which can be attributed to its expanded role in space. More recently, capital investment by the other firms has also increased: capital expenditures amounted to $3.3 million in the past two years, over twice the amount in earlier years.

Assets have grown at a much faster rate than sales. Total assets amounted to $80 million in 1980, up from $17 million in 1976.

On the whole, the companies have invested little in working capital. Although all firms had positive net working capital positions, net working capital was equivalent to as little as ten days of sales in some cases. Inventories including work-in-process were typically the equivalent of one month of sales. Total net working capital amounted to $8.2 million, for sales of $157 million. At the same time, total current assets reached approximately $60 million.

## Financial Returns

The profitability of Canada's space activities has varied considerably over the past few years. Total profits in 1980 amounted to $3.1 million, up from only $597,000 in the previous year. This poor performance was primarily due to the loss incurred by SPAR in that year.[1] As shown in Exhibit 4, opposite, net profit as a percentage of sales in 1980, nevertheless, was still relatively low, at 2.0%, when compared to the peak of 3.5% achieved in 1978. Gross margins have averaged 7.2% of sales since 1976.

The performance of the five companies excluding SPAR has been somewhat better. Margins for these companies tend to be higher: the five companies since 1978 have experienced net profits of 7.2% of sales and gross operating profits of 13.1% of sales on average.

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[1] This loss was caused by large increases in depreciation, interest changes and employee termination settlements, and does not indicate a deterioration in SPAR's operating performance.

R&D Expenditures

In 1980, R&D expenditures, net of any government grants, amounted to just over $3 million, a fivefold increase since 1976. As a percentage of sales, this amounted to 2.1%, a level which has typically been about 2.3% in recent years. This R&D effort has been considerable when viewed as a percentage of net profits: R&D expenditures in most years have exceeded net profits.

The five firms excluding SPAR have put a relatively greater emphasis on R&D. For the five companies, R&D expenditures averaged 6.1% of sales since 1976.

The figures quoted above pertain only to internally funded R&D activities. In addition, the firms undertook R&D on behalf of government (as part of government development contracts) which is counted as sales. Furthermore, they received government assistance by way of direct grant to undertake R&D work. These amounts are excluded from the above figures. An estimate of total R&D activities by these firms would be as much as twice the amounts actually shown on the companies' financial statements.

EXHIBIT 5

GLOBAL MARKET PROSPECTS

| | Current Market | | Annual Growth Prospects |
|---|---|---|---|
| | US | All Other | |
| | ($ million) | | |
| Satellite Systems: | | | |
| - Civil | 5,740 | 2,350 | <10% |
| - Commercial | 140 | 430 | >25% |
| - Military | 4,910 | 470 | 20% |
| Sub-Total | 10,790 | 3,250 | |
| Remote Manipulator Systems | 50 | - | 15% |
| Scientific Application | 20 | 14 | <10% |
| Total | 10,860 | 3,264 | |

Source: Canadian Space Industry
Marketing Opportunities in the 80's
Department of Industry, Trade and Commerce

# III - GENERAL MARKET OUTLOOK

## GLOBAL MARKET

Industry specialists generally predict a buoyant market for the space industry as a whole, led by developments in the United States. Space sales, including satellite and terrestrial facilities, are estimated to amount to approximately $14 billion annually. The US market alone is estimated at over $10 billion in sales, with NASA's Space Transportation Program and military purchases accounting for a large portion of expenditures. Markets in Canada, Japan, Europe, and, to a lesser extent, oil-rich and developing countries account for the balance.

The Department of Industry, Trade and Commerce has recently completed a comprehensive study of the global market for space products. This study analyzes in detail the 58 civil and commercial systems and 17 military programs which make up the above market forecast. According to that survey, the space market can be divided into three principal client groups: civil or government space programs typically for communications, scientific, meteorological, navigational and resource applications; military programs (surveillance, communications, and defence-related programs); and commercial programs largely for communications purposes.

As shown in Exhibit 5, opposite, the overwhelming share of the satellite systems market is in the civilian sector. This market segment, however, is dominated by political factors, which can often override economic considerations. Because these expenditures are dependent on government budgetary situations, this segment is not expected to have high growth prospects -

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1 See Canadian Space Industry: Marketing Opportunities in the 80's, Industry, Trade and Commerce, 1980.

civil sales are forecast to grow at less than 10% per annum. Major purchases in most instances will be directed to domestic suppliers. However, opportunities still exist for Canadian firms, especially in regional programs.

The next largest market for satellite systems is found in the military sector. This market is dominated by purchases by the US government. Here, the emphasis is on technologically advanced equipment, with procurement limited almost exclusively to domestic firms for security reasons. Canadian firms should not expect to gain a large portion of this market. However, spurred by greater funding commitments to defence in the United States as well as by closer collaboration between Canadian industry and US defence officials, there are indications that Canadian companies may have greater prospects in this rapidly growing market than in previous years.

The final market segment is the commercial sector. This sector is thought to constitute the fastest growing market. Growth is predicted at greater than 25% per annum, albeit starting from a relatively small base of $500-600 million. The commercial market is particularly buoyant in the United States where regulatory relaxation has permitted more participants, and user sophistication has increased the demand for advanced communications. The demand for communications services in areas such as cable television, pay-TV, direct broadcasting, teleconferencing, video transmission and data communications is expected to grow considerably. Commercial applications are also expected to develop in maritime communications, airborne radar, mobile communications, and remote manipulation systems. The ground segment will be particularly important in these developments.

Competition faced by Canadian firms in these international markets is stiff. The space industry has long been dominated by US firms such as Hughes Aircraft Co., General Electric, Ford Aerospace, Rockwell International, TWR, and RCA Astronautics. These companies have been prime contractors for the INTELSAT series, the Anik series (up until Anik-D), and US commercial systems (SATCOM, Westar, Comstar, SBS).

More recently, European and Japanese manufacturers have gained in strength as a result of increased concern over the US dominance of the space industry. Prime British space capabilities have been consolidated under British Aerospace, while in France, industry has grouped around Aerospatiale, and in Italy, under Aeritalia. German companies active in space include Messerschmitt-Boelkow-Blohm (MBB), Dornier System and ERNO. Japanese companies, primarily Mitsubishi and Nippon Electric, are also working to improve their own technology and to reduce their reliance on US facilities. All of these companies are being encouraged by regional and national civil programs such as ESA's L-SAT, Space Lab and Ariane Launcher, national direct broadcast programs in France and Germany and bidding in civil programs in other countries (for example, the Arab States, Mexico and Africa). However, few of these companies have demonstrated their international competitiveness for entire satellite systems, and most rely on directed procurement, bid support, and subsidies to win major prime contracts.

The competitive situation in the ground segment and for specialized components is somewhat different. There are more participants, ranging from the major satellite manufacturers listed above to specialized companies such as Scientific Atlanta and Microdyne. Non-American companies also have been stronger in this side of the space industry. Mitsubishi and Nippon Electric, for example, have built complete earth stations and major subsystems for INTELSAT in over 60 countries. This is also the area where Canadian firms excel.

By far the fastest growing segment of the ground station market is likely to be that for small, low-cost satellite earth stations. Japanese firms are expected to be particularly effective in this area, providing considerable competition for US firms. Market projections indicate that sales of ground equipment could grow at 40% annually and reach 100,000 installations in the United States by 1990.

## OPPORTUNITIES FOR CANADIAN COMPANIES

In light of the expanding markets for satellite systems, especially in the commercial sector, most Canadian firms are anticipating commensurate growth in their own operations. Part of this optimism is due to the generally expanding markets internationally, and part to the prospects for Canadian firms increasing their market shares. That is to say, Canadian firms expect their competitive positions to improve in the coming years.

At this point, it is difficult to judge the reasonableness of this assertion. Certainly, the market offers an abundance of opportunity for Canadian firms if they can capitalize on those opportunities. However, it is still difficult to translate global opportunities into sales for individual companies.

As a general rule, Canadian firms tend to position themselves in markets that are technology-driven. Firms specialize in particular components and satellite subsystems that are sophisticated and require a certain amount of customization. The skills of Canadian firms in the engineering and systems areas are particularly strong. The international success of Com Dev attests to this claim.

Typically, Canadian industry has been at the leading edge of technological developments. The Hermes experiments resulted in Canadian expertise being developed in direct broadcast in the 1970's. Only now is the market for DBS developing in the US, Japan and Europe, and Canada has yet to commercialize that technology. Similarly, Canadian strengths in remote sensing, satellite-aided search and rescue systems, and, more recently, remote manipulator systems give Canadian firms unique capabilities in those areas. Commercial markets for these products are expected to develop over the next five or more years.

Few Canadian firms are at the stage of producing for mass markets such as that emerging for low-cost earth stations. This market will require firms to be cost-competitive and to produce in volume. It is likely that most Canadian firms, not having a large domestic market on which to base their production runs, will have considerable difficulty in establishing themselves in the US market. It can be expected that US firms already known in that market and having a very large market base will dominate. Japanese firms, skilled in mass production of low-cost electronic goods, will be challengers. That is not to say that Canadian firms offering a good product should not be able to sell successfully in the market for ground stations. However, they should not expect to command a large market share on their own.

Canadian firms are presently weakest in their ability to undertake entire satellite systems. Here, SPAR, the only Canadian firm with the potential to act as a prime contractor[1], is disadvantaged since it lacks a unique satellite bus technology and must pay license fees to Hughes (or British Aerospace for using L-SAT outside Canada). Furthermore, SPAR has not yet reached a volume of business which permits it to attain economies of scale and other production efficiencies.

At present, SPAR is following a strategy of deepening its capabilities through the Anik-D program, the first time SPAR will have acted as prime contractor for a major satellite system. It is also broadening its capabilities by participating in ESA's L-SAT program. Through this program, SPAR will acquire new skills in solar array systems and testing and integration. Although SPAR has yet to win a major international contract, its competitive position is reported to be improving: the difference between SPAR's bids and the lowest bids on recent international tenders has narrowed. The long-term prospects for SPAR as prime contractor will be dealt with in depth in another study.[2]

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1 SPAR's role as prime contractor is subject to a close examination in a study concurrent with this one.

2 The prime contractor review is currently underway. Its conclusions are yet to be released.

PREREQUISITE FOR ACHIEVEMENT

In light of the space market's inherent risks, its rapid technological advances, and its strong political overtones, it becomes extremely difficult to rationalize and predict its development. It is even more difficult to prescribe a formula of success for the industry. However, there may be lessons to be learned from the industry's past experience.

One of the keys to long-term success in the space market has been to anticipate market developments. Canadian firms have in the past been at the fore of certain technological developments - for example, remote sensing and remote manipulator systems - which hold promise of wide commercial markets. Strong national programs, in particular, have been extremely helpful in providing industry with an advanced opportunity to demonstrate and perfect prototypes in Canada before marketing their products abroad. If initial development costs can be recouped from government sales, future sales can be made at substantially lower prices, thereby enhancing the product's international competitiveness.

Another requirement for a successful space industry is to supplement the resources of industry to support R&D activities. None of the firms in Canada is currently is a position to adequately sustain a space R&D program. Even with relatively high percentages of sales devoted to R&D - as much as 10-15% of sales - the absolute amounts put into R&D by Canadian firms are limited.[1] Continued government R&D funding as well as transfer of technology developed in government laboratories to industry are essential to enable the space industry to keep abreast of technological development.

Close international cooperation is also vital to permit Canadian industry the opportunity to participate in certain regional programs. Without preferential access, such as that gained from ESA associate membership, Canadian

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[1] Internally funded R&D in 1980 is estimated at $3 million which is equivalent to industry's net profits in that year.

firms would be effectively locked out of most space business opportunities. While firms may be confined to a limited area and may even run the risk of divulging their technology when participating in cooperative programs, such collaboration nevertheless makes possible future sales to other members of the cooperative body. It is important that government continue to facilitate industry's participation in international programs.

The evolution of the space market into commercial applications is likely to place different demands on industry. Cost-effectiveness becomes important, perhaps more so than in either the civil or military markets. It may be necessary for industry to produce less technologically sophisticated equipment at lower costs. High volumes are also required to amortize initial development costs. This transformation to a production orientation by Canadian firms will likely call for more investment in capital goods and greater attention to marketing and productivity by industry than in the past. Capital assistance by government will likely be required to overcome this potential barrier[1] to Canadian firms in entering mass markets in which they currently have little experience.

The ultimate responsibility for successful exploitation of market opportunities, nevertheless, rests with management. It is largely up to industry to identify potential markets and to satisfy those markets with products that are competitively priced. It is also up to industry to ensure that their sales yield sufficient profit to sustain the expansion of these enterprises and to generate returns to investors. This requires a concern for operational efficiency and internal control. In high technology areas such as space, the management of highly skilled manpower is of primary importance. Without the accumulated knowledge found in Canada's high technology industries, prospects for long-term success in space would be slim.

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1 In 1980, capital expenditures in space amount to about $6.3 million, a sixfold increase since 1976 and twice as much as 1980's net profits for the industry.

## EXHIBIT 6

## CANADA'S CURRENT SPACE PROGRAM

| | 1981/82 | 1982/83 ($'Million) | 1983/84 |
|---|---|---|---|
| Remote Sensing | | | |
| . Current Programs | 17.5 | 16.9 | 17.2 |
| . New Programs | 10.2 | 15.6 | 13.8 |
| TOTAL | 27.7 | 32.5 | 30.0 |
| Technology Development | | | |
| . Current Programs | 17.8 | 7.3 | 6.0 |
| . New Programs | 9.2 | 4.8 | 6.1 |
| TOTAL | 27.0 | 12.1 | 12.1 |
| Communications | | | |
| . Current Programs | 24.3 | 19.3 | 16.0 |
| . New Programs | 1.6 | 1.8 | 1.3 |
| TOTAL | 25.9 | 21.1 | 17.3 |
| Space Science | 13.8 | 17.4 | 18.1 |
| Other On-going Programs | 1.7 | 1.8 | 1.2 |
| TOTAL | 96.1 | 84.9 | 79.7 |

# IV - PROSPECTS FOR THE INDUSTRY

## CANADA'S SPACE PROGRAM

As shown in Exhibit 6, opposite, Canada's current space program amounts to $260.7 million over the next three years (1981/82 to 1983/84).[1] The continuation of ongoing programs represents 75% of total expenditures. Annual expenditures average $87 million in current dollars, which represents a decline of some 10% in nominal terms and over 30% in real terms since the peak in government space activities reached in 1979. After the period of expansive activity in the late 1970's, the space industry is now faced with a levelling off of activity by the federal government, as time is taken to assess the industry's performance and reflect on government priorities in space.

### New Initiatives

One of the principal thrusts of Canada's present space program is remote sensing, which enables satellites to be used for resource management as well as territorial and environmental surveillance. Key elements of the remote sensing program include upgrading of existing earth stations to receive and process data from LANDSAT-D to be launched in 1983, preliminary studies of a satellite program (RADAR-SAT) using synthetic aperture radar (SAR), and participation in ESA's remote sensing program. The latter is a possible option for Canada to follow if it decides not to proceed with RADAR-SAT on its own. These new activities supplement ongoing R&D programs in the areas of oceanographic, meteorological, and airborne applications. In total, $91 million will be devoted to remote sensing activities.

The other major program initiatives are in the area of communications, for which $64.3 million has been allocated. In addition to the studies of a

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[1] See MOSST, The Canadian Space Program for 1981/82 - 1983/84, Background Paper Number 19, April 1981.

mobile satellite system (M-SAT), approved in last year's space program, studies were recently approved on a direct broadcast satellite system (DBS). The communications side of Canada's space program also includes ongoing programs for the expansion and operation of David Florida Laboratory (DFL), Anik-B experimental programs, Search and Rescue Satellite (SAR-SAT) and military communication applications.

A third major area of new programs in the 1981/82 - 1983/84 period is in technological development with commitments amounting to $51 million. This encompasses programs such as Canadian participation in ESA's L-SAT program, and additional funding for DOC's industrial support activities. These increases complement existing space programs such as the Remote Manipulator System, bid support to industry, and the premiums paid to Telesat for Anik-C and-D.

Space science is the fourth major area of government expenditure. Although no new space science program was announced in the latest space program, substantial funding has already been allocated for NRC's joint Space Science Program with NASA. In total, about $41 million is to be spent on the development and manufacture of state of the art spaceborne instruments which could, for example, be used for experimentation aboard the US Space Shuttle.

Canadian industry is expected to undertake a major part of the space activity resulting from the above space program. In past years, industry's involvement amounted to about 55% to 75% of total government expenditures. Assuming this level prevails in the future, Canadian industry can expect government programs to generate some $50 to $65 million in annual sales in the period 1981/82 to 1983/84. The major part of these sales would be in the space segment, with lesser amounts in ground facilities and data handling.

The present space program offers the promise of much higher levels of government expenditure in 1983 and subsequent years if the major satellite programs currently being studied are realized. Over the next two years, government is expected to take decisions on its participation with ESA in the L-SAT program and on its investment in RADAR-SAT, M-SAT, and DBS, all of which are now under study. If some combination of these major programs were undertaken in the coming years, Canada's space industry is likely to move into another cycle of high activity.

## INDUSTRY SCENARIOS

In order to gauge the impact of possible government space programs on Canadian industry, three scenarios were developed, representing high, medium and low levels of government direct involvement in space. These scenarios are based on the assumption that government has the option of going ahead or not with the four major space programs currently under study - L-SAT, RADAR-SAT, M-SAT, and DBS - over the next five years. It was further assumed that in the coming five years, a maximum of three satellite programs would be feasible, representing the high scenario (Case 3), and a minimum of one program, representing the low scenario (Case 1 or base case). Two satellite programs constitutes the medium scenario (Case 2). The following program cost estimates are preliminary and subject to further refinement and precision as the studies now underway progress.[1]

### Scenario One

Because it is furthest advanced and a decision by Government to go ahead is anticipated in late-1981, the first scenario or the base case consists of the L-SAT program only. Participation in L-SAT requires that Canada contribute to ESA's operating overheads and general studies, as well as paying a share of the total L-SAT program costs that corresponds to the share of L-SAT contracts won by Canadian industry.

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[1] In converting cost estimates into current year dollars, inflat on rates of 10.2% in 1981/82, and 9% annually thereafter were used.

It is currently anticipated that SPAR will win the contract for construction of the solar array sub-component, which it would develop with European manufacturers. The total value of this contract to SPAR is estimated at about $18-20 million. It is further expected that the test and integration activities will be undertaken by SPAR (using the David Florida facilities) for a value of about $6 million. In addition, CAL has bid on contracts for battery management (about $4 million), and Com Dev on microwave equipment (about $3.5 million). Smaller contracts could also be won by other firms. The total value of contracts likely to be won by Canadian firms is therefore expected to be about $30 million, with Canada's share being 10 to 15% of the total program cost.

The total cost to the Canadian government for L-SAT would be approximately twice industry's participation. Including Canada's contribution to L-SAT's study phases, L-SAT costs are estimated at about $74 million (current $) in the period 1981/82 to 1985/86. Peak expenditures of over $24 million annually are forecast for 1983 and 1984 corresponding to the satellite manufacturing stage.

The anticipated incremental cash flow for L-SAT and for the total space program is as follows:

| | 1981/82 | 1982/83 | 1983/84 | 1984/85 | 1985/86 |
|---|---|---|---|---|---|
| | | | ($ million current) | | |
| L-SAT | 10.1[1] | 24.4 | 23.8 | 13.2 | 2.8 |
| Current Program | 96.1 | 84.9 | 79.7 | 50.0(E) | 50.0(E) |
| Total | 103.1 | 109.3 | 103.5 | 63.2 | 52.8 |

(E) Estimate

The addition of L-SAT would increase government space expenditures in the three coming years by $55 million or 21% over the current program.

1 $3.1 million in expenditures for on-going work on L-SAT have already been included in the 1981/82 - 83/84 space program.

EXHIBIT 7

ESTIMATED COSTS

RADAR-SAT

| | 1981/82 | 1982/83 | 1983/84 | 1984/85 | 1985/86 | 1986/87 |
|---|---|---|---|---|---|---|
| | | ($ million current year) | | | | |
| RADAR-SAT[1] | 1.6 | 10.0 | 55.2 | 81.9 | 72.2 | 22.8 |
| Ground Stations | - | - | - | 5.2 | 28.5 | 14.0 |
| Cumulative Total[2] | 103.1 | 112.4 | 151.6 | 150.3 | 153.5 | 36.8 |

[1]Portion of expenditure for 1981/82 - 1983/84 already included in current space program.

[2]Excludes any on-going programs past 1985/86.

## Scenario Two

The medium level scenario includes the L-SAT program plus one other satellite program starting in the period 1981/82 - 85/86. Of the three programs being studied, RADAR-SAT was chosen to be included in the second scenario.[1]

It is anticipated that SPAR would act as prime contractor for RADAR-SAT, with CAL and MDA contributing to the program in the initial study phase, and CAL for the battery management system. Other companies such as Com Dev would also expect to be subcontractors to SPAR during the course of satellite construction. As prime contractor, SPAR would likely obtain over 85% of the satellite cost (excluding launch and ground station costs) directly. Overall, at least 50-60% Canadian content could be achieved. In addition, investment in ground stations would likely go to firms such as MDA and SED Systems.

The estimated cash flow for RADAR-SAT and the cumulative program total are presented in Exhibit 7, opposite. The proposed RADAR-SAT expenditure increases total space expenditures by some $291 million (current $) overall (including ground stations, but excluding launch costs and initial operations). In the three year period 1981/82 to 1983/84, government expenditure would increase by about $50 million (19% over the current program and 16% over the current program plus L-SAT), bringing government annual space expenditures to over $150 million by 1983.

## Scenario Three

The third scenario has government undertaking three major satellite programs - L-SAT, RADAR-SAT and either M-SAT or DBS. Both M-SAT and DBS are now in

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[1] There are currently several options being considered for RADAR-SAT: an all-Canadian option, a joint venture with NASA, and participation in ESA's remote sensing program. At the moment, prospects for the latter two options are dim due to NASA budgetary cutbacks and the incompatibility of Canadian needs with the European proposal. The all-Canadian option was therefore included in this study.

the early study phases, and precise cost estimates are not available. Costs are assumed, for simplicity sake, to be approximately the same amount.[1] Both are assumed to be all-Canadian programs, with no international cooperation.

The sequencing of the programs could vary: for example, Case 3 could have L-SAT followed by M-SAT then RADAR-SAT or vice-versa. SPAR, for the purposes of the study, chose to prepare its forecast with M-SAT before RADAR-SAT. Other firms like CAL and Com Dev for which the two programs are close substitutes, provided material with RADAR-SAT first. These differences, however, should not have a material effect on the study's results.

The proposed DBS program has two major options. One alternative is an interim DBS program using Anik-C with no incremental satellite costs (only ground stations) for the first four to five years, followed by dedicated DBS system, launched about 1988/89. The other is a special DBS system developed as quickly as possible, with launch planned for about 1987. Since the differences are not great in real terms (only timing), the option with the later launch was assumed.

Canadian industry's participation in the M-SAT and DBS program is anticipated to reach at least 55-60% of total expenditures. Again, SPAR would act as prime contractor with subcontracts to Canadian companies like Com Dev for microwave equipment and CAL for battery management. SED Systems and Raytheon could be involved in large earth stations. In both cases, firms not primary in space could be involved in supplying the user-procured terminals and low cost earth stations. For M-SAT, firms experienced in mobile radios, for example, will have opportunities. For DBS, possibilities would exist for a large number of firms including SED Systems through its connection with General Instruments.

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[1] Based on preliminary estimates of satellite construction (excluding launch and ground facilities) DBS could cost from $160 to 250 million (1981 $). M-SAT estimates range from about $190 million to $240 million (1981 $) depending on system definition, payload and NASA participation. DND payloads estimates have not been included in the estimated program cost.

EXHIBIT 8

ESTIMATED COSTS

M-SAT OR DBS

| | 1981/82 | 1982/83 | 1983/84 | 1984/85 | 1985/86 | 1986/87 | 1987/88 | 1988/89 |
|---|---|---|---|---|---|---|---|---|
| | | | ($ million current year) | | | | | |
| M-SAT or DBS | 1.7[1] | 4.0 | 16.3 | 49.8 | 60.5 | 57.4 | 68.2 | 40.3 |
| Cumulative Total[2] | 103.1 | 116.4 | 167.9 | 200.0 | 214.0 | 94.2 | 68.2 | 40.3 |

[1]Expenditures for 1981/82 already indicates in current Space Program

[2]Excludes any on-going programs past 1985/86

For purposes of this study, costs for M-SAT and DBS are assumed to be approximately $170 million (current 1981 $) excluding ground facilities, launch, and post-launch operations. It is also assumed for this presentation is that RADAR-SAT comes first followed by DBS or M-SAT.

The resulting costs for the third scenario are presented in Exhibit 8, opposite. Total M-SAT or DBS costs would reach about $298 million (current year $) and would bring peak government expenditures to over $200 million (current year $) in 1984/85. In the period 1981/82 to 1983/84, government expenditures would increase by about $20 million (6% over Case 2) as major program costs would not be incurred until the late 1980's.

## INDUSTRY FORECASTS

The six companies participating in this study - SPAR Aerospace, MacDonald Dettwiler & Associates (MDA), SED Systems, Com Dev, Miller Communications Systems and Canadian Astronautics Co. Ltd. (CAL) - were asked to furnish detailed financial projections for each of the above three scenarios, indicating how the prospects for their companies would change under each scenario. Not all the firms anticipated that these major satellite programs would affect their business plans significantly: Miller and SED Systems both forecast that the differences in the scenario would have little impact on sales; hence, only one forecast, assumed to be constant in each scenario, was prepared by those two companies. MDA predicted that the second scenario, L-SAT plus RADAR-SAT, would affect its business and prepared two forecasts: one representing the base case (L-SAT only) and one for the second (L-SAT plus RADAR-SAT). The remaining three firms indicated that each scenario would have an impact on their sales forecast and provided sufficient material to prepare three forecasts.

To provide continuity with past data collected from these firms, the Business Forecast Enquiry undertaken annually by the Air Industries Association of Canada (AIAC) was used as the model of the information required for this study. Details of the companies' sales, costs, investments, and employment

## EXHIBIT 9

### SUMMARY OF BUSINESS FORECASTS

($ million 1981)

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| TOTAL SALES | | | | | | | | | | |
| CASE 1 | 107.4 | 132.9 | 141.4 | 177.7 | 188.7 | 232.4 | 276.0 | 324.2 | 377.5 | 439.8 |
| CASE 2 | 112.8 | 145.1 | 178.6 | 220.2 | 249.6 | 305.1 | 353.3 | 412.5 | 478.9 | 558.0 |
| CASE 3 | 114.3 | 171.2 | 205.5 | 264.1 | 320.7 | 385.1 | 441.4 | 510.2 | 586.3 | 675.3 |
| EXPORTS | | | | | | | | | | |
| CASE 1 | 65.1 | 80.9 | 89.2 | 105.0 | 124.1 | 150.2 | 177.5 | 207.4 | 241.3 | 280.8 |
| CASE 2 | 65.1 | 81.9 | 80.5 | 111.3 | 138.0 | 168.1 | 203.4 | 243.4 | 288.3 | 343.7 |
| CASE 3 | 65.1 | 83.6 | 95.6 | 118.3 | 146.2 | 178.9 | 216.4 | 259.2 | 307.8 | 365.6 |
| NET CASH FLOW* | | | | | | | | | | |
| CASE 1 | 1.8 | 3.5 | 0.8 | 6.2 | 9.5 | 6.9 | 16.8 | 22.6 | 14.0 | 32.7 |
| CASE 2 | 1.4 | 2.4 | 1.5 | 8.3 | 10.3 | 10.5 | 19.9 | 25.4 | 16.3 | 35.3 |
| CASE 3 | 1.3 | 3.2 | 4.0 | 15.2 | 23.2 | 26.9 | 37.6 | 44.5 | 37.3 | 56.2 |
| GROSS R&D | | | | | | | | | | |
| CASE 1 | 5.4 | 7.0 | 7.9 | 9.0 | 10.2 | 13.7 | 16.5 | 19.7 | 24.0 | 28.3 |
| CASE 2 | 5.8 | 8.5 | 11.1 | 13.2 | 15.2 | 20.2 | 23.3 | 28.1 | 29.4 | 40.1 |
| CASE 3 | 6.0 | 10.0 | 13.1 | 17.7 | 22.6 | 28.3 | 31.2 | 37.8 | 44.1 | 51.8 |

* Excludes Interest and Taxes

as requested in that inquiry were obtained for the period 1981 to 1990. In addition, the companies were asked to provide estimates of the foreign exchange components of planned production and investment, inflation assumptions, sensitivity of profits to volume changes, R&D support and other government assistance. These estimates, adjusted in some instances, formed the basis of the assessment of the economic and social impact of Canada's space program, presented in the following chapter. In addition, the firms were asked their views on labour availability and the marketing strategies they expect to pursue in achieving their sales forecasts.

To supplement the projected cash flows provided by each company, certain other assumptions were made. First, to reflect the company's current position, the net fixed assets and net working capital as of the end of the 1980 fiscal year were taken as the 1981 starting point. Second, additional investment in working capital was assumed to take place in order to maintain a net working capital position equivalent to one-half month's sales. Third, the full value of working capital and net fixed assets[1] was assumed to be recovered in 1990 at the end of the forecast period.

Exhibit 9, <u>opposite</u>, presents the aggregate forecast for six firms in the study. Details for each individual company are contained in Appendix C.

## Sales

Having enjoyed a record of rapid growth, averaging about 35% annually in the past, the firms are predicting continued high growth in the period 1981-1990. Overall, sales (in 1981 $) are expected to grow at rates varying from 17% to 22% annually depending upon which scenario is assumed. Under the first scenario, sales increase from $107.4 million in 1981 to $439.8 million in 1990. The high scenario has sales reaching over $675 millilion by 1990. In

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[1] Plant was assumed to be depreciated over 10 years, and equipment over 3 years, on a straight line basis.

all cases, the rate of growth is expected to diminish in later years: in the period 1987 to 1990, sales grow at an average rate of about 15%. The impact of the increased government space expenditures is felt primarily in the period 1981 to 1985 when annual rates of growth average between 17% for Case 1 and 28% for Case 3.

## Exports

The companies' exports in the period 1981-1990 take on increasing importance in overall sales. In Case 1, with government domestic purchases relatively low, the companies expect to substitute at least partially with increased exports. Exports under Case 1 grow at an average of 18% annually and increase from about 60% of total sales to 64% of total sales by 1990, albeit on a small sales base. Under the other two scenarios, the share of exports in total sales falls in the early years as government expenditures under the major programs increase. Nevertheless, exports continue to expand rapidly and reach an estimated 55% to 60% of sales by 1990. Depending on the scenario, exports are predicted to reach between $280.8 million and $365.6 million in 1990, from a level of $65.1 million in 1981.

## Net Cash Flow

The net company cash flow (before interest and taxes) that results from these sales varies from year to year. It steadily increases from an average of about $2 million annually in the first three years of the forecast period to an average in the last three years of $23 million under Case 1, $26 million under Case 2, and $46 million under Case 3. As a percentage of sales, the cash flow improves from about 1% of sales to a maximum of about 7 to 8% of sales under Case 1 and Case 3. There is some deterioration under Case 2, because of high R&D costs associated with RADAR-SAT, which reduce the net cash flow to about 6% of sales. In most instances, this level of cash generation enables the individual firms to cover their anticipated investments. However, in the early period, and periodically throughout the forecast period, certain firms are not able to generate sufficient cash to finance

## EXHIBIT 10

## EMPLOYMENT FORECAST

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1990* |
|---|---|---|---|---|---|---|
| | | | (Persons) | | | |
| CASE 1 | 1578 | 1847 | 2063 | 2331 | 2657 | 4427 |
| CASE 2 | 1640 | 1987 | 2498 | 2890 | 3322 | 5586 |
| CASE 3 | 1651 | 2233 | 2709 | 3307 | 3997 | 6674 |

* Study Estimates

R&D and investments, resulting in negative cash flows. External sources of financing will likely be required in those cases, especially when it is remembered that the net cash flows in the above analysis are before interest payments and taxes.

## Gross R&D

The companies anticipate that their R&D activities will grow even faster than sales. Under the three scenarios, gross R&D expenditures increased at an average of 20 to 27%, reaching between $28.3 million and $51.8 million in 1990. As a percentage of sales, gross R&D currently represents about 5% of total sales.[1] As the profitability of the companies improves, this level is expected to increase to about 6 to 7% of sales depending on the scenarios. Under Case 3, with the greatest cash generation, gross R&D amounts to 7.7% of total sales in 1990. In all cases, gross R&D expenditures are roughly equivalent to the companies' net cash flow before interest and taxes.

## Employment

Commensurate with the growth in sales forecast by the companies, the demand for labour also increases. As shown in Exhibit 10, opposite, the industry's total employment could reach as much as 6,674 persons by 1990. The rate of increase in employment, however, is anticipated to be less than that in sales: employment increases by 12 to 17% per annum. This reflects, in part, improvements in productivity, and greater use of capital as some firms shift to more capital-intensive modes of production. The relatively rapid increases predicted by industry, nevertheless, reinforce the view that the space industry will continue to rely heavily on its labour force to produce custom-designed equipment with high local value-added. Sales per employee increase from about $68,000 in 1981 to over $100,000 in 1990.

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[1] As a rough approximation, gross R&D expenditures are estimated to be about twice as much as net R&D expenditures (that is, after government grants). In 1979-80, net R&D averaged 2.3% of sales.

# V - RETURN ON INVESTMENT

Return on investment has several meanings, depending on the perspective taken. For the private investor it indicates the return he receives on the financial resources he has invested in a business. For the Canadian government it is the social return earned on all resources committed by the nation (both by the private investor and by the government). Regardless of the perspective, return on investment calculations deal only with items that can be quantified in monetary terms. Although such calculations are important, they are not all-encompassing. Projects can generate future benefits which cannot be quantified. These may include, for example, a technological capability which will eventually yield quantifiable economic benefits, the magnitude of which cannot be forecast at this time.

In this section of the report we deal primarily with the quantifiable aspects of return on investment. Non-quantifiable considerations are briefly discussed at the conclusion.

## PRIVATE RETURN ON INVESTMENT

A private investor will generally undertake a project (or continue the operation of a company) only if he receives a return on his invested equity sufficient to compensate him for not investing his money elsewhere and for any risk elements involved. The ultimate return on equity received by a shareholder will be affected by both the operating profitability of the project and the financing arrangements (i.e., how much of the total project costs are financed with equity and how much are financed with debt and at what rates). Projects with the same operating margins, therefore, can yield significantly different returns on equity.

# EXHIBIT 11

## PRIVATE RETURN ON INVESTMENT

| | Base Case | Base Case Plus RADAR-SAT | Base Case Plus RADAR-SAT PLUS M-SAT |
|---|---|---|---|
| Industry-Wide Results | 38% | 40% | 53% |

Return on investment calculations, on the other hand, reflect the overall operating performance of a project. Return on investment gives an indication of whether or not a project would be attractive to a private investor regardless of the financing arrangements. It is this calculation that we have done for this study.

With the exception of one company under the Base Plus RADAR-SAT scenario, all the scenarios show private rates of return on investment in excess of 20 per cent and range upwards to the 80 per cent level. These rates of return are real (i.e., the distorting effects of inflation have been removed), and all are calculated before corporate income taxes. Overall, the industry shows an internal rate of return of about 38% for Case 1, 40% for Case 2 and 53% for Case 3.

These rates of return (once again, with one exception under Case 2) are exceedingly high when compared to the historical returns of manufacturing in general of 12 to 13 per cent (before tax and net of inflation). Furthermore, they make no allowance for the value of the on-going business past 1990. Thus, despite the risk involved in operating in a high technology environment which is rapidly changing, the forecast rates of return tend to indicate that the companies should not have great difficulty in attracting the capital necessary for expansion.

There are two qualifications to this conclusion, however, which must be noted.

- First, the rates of return are based upon forecasts prepared by the companies. Although we have discussed and reviewed the forecasts with the companies, we have not, in any sense, confirmed or validated them. It is possible that the companies are overly optimistic with regard to their future sales and profitability.
- Second, it would appear that capital is not the critical variable in analyzing the results of the space industries as conventional financial analysis generally assumes. These are technology- or knowledge- intensive businesses rather than capital-intensive. It does not follow,

therefore, that the companies could double their profits by doubling the amount of capital they have invested in the business. A shortage of skilled labour and knowledge workers could restrain the rate of growth. The rates of expansion postulated by the six companies could therefore be limited by such shortages or by the technological and management problems inherent in a rapidly growing business.

As noted above, the space industries are not capital-intensive. Part of the reason for the very high forecast internal rates of return is the fact that they have very little capital invested in the business compared to the level of sales generated. Conventional techniques of financial analysis may not, therefore, be the best tools to use in analyzing this type of business. Alternatives have not, however, been developed to handle knowledge-intensive industries such as space.

## RELATIONSHIP BETWEEN PRIVATE RETURNS AND SOCIAL RETURNS

The private rate of return on investment measures the rate of return to the private investor who invests his money in a project. In an economic environment where perfect competition prevailed, this private rate of return would approximate the social rate of return. In reality, however, the market is distorted. The social return to Canada, while based upon the private rate of return, adjusts private cash flows to correct for the distortions in the market.

These distortions can occur as a result of the following:

- For social and private rates of return to be equal, the market must consist of many buyers and sellers. This is often not the case. Large corporations, government and labour unions can possess significant market power.

- Even in cases where there are many producers and consumers, prices may be determined by non-market forces. Government regulations may influence or determine prices. Minimum wage legislation is one example of this type of intervention. Another is that the foreign exchange rate may be determined by the central bank.

## EXHIBIT 12

### SOCIAL RETURN ON INVESTMENT
(Net Present Values in millions of 1981 dollars)

| | Base Case | Base Case Plus RADAR-SAT | Base Case Plus RADAR-SAT PLUS M-SAT |
|---|---|---|---|
| **Company Results** | | | |
| Private Returns | $ 71.1 | $ 82.0 | $ 143.8 |
| Premium on Foreign Exchange Generated (15%) | 123.8 | 137.9 | 146.2 |
| Premium on Foreign Exchange Saved (15%) | 72.0 | 106.2 | 149.2 |
| Labour Benefit (10%) | 41.0 | 50.3 | 58.6 |
| Social Benefits | $ 307.9 | $ 376.4 | $ 497.8 |
| Direct Government Grants and Subsidies | (33.4) | (47.9) | (56.3) |
| Premium on Foreign Exchange Use (15%) | (36.2) | (51.9) | (66.9) |
| Sales Tax Foregone (4%) | (14.8) | (18.1) | (21.1) |
| Increase in Physical Inventory | ( 5.7) | ( 8.2) | (12.0) |
| Social Costs | $ (90.1) | $(126.1) | $(156.3) |
| Net Social Benefits | $ 217.8 | $ 250.3 | $ 341.5 |
| **Industry Adjustments** | | | |
| L-SAT Expenditures (including Foreign Exchange Premium) | (54.0) | (54.0) | (54.0) |
| David Florida Laboratory | (21.8) | (21.8) | (21.8) |
| Premium on Anik C-D | (3.8) | (3.8) | (3.8) |
| RMS Production Support | (4.9) | (4.9) | (4.9) |
| Bid Support Program | (9.2) | (9.2) | (9.2) |
| Industrial Contracts Fund | (30.7) | (30.7) | (30.7) |
| ESA Remote Sensing | (3.5) | (3.5) | (3.5) |
| Subtotal | $(127.9) | $(127.9) | $(127.9) |
| Industry Social Return on Investment | $ 89.9 | $ 122.4* | $ 213.6* |

*Excludes possible price premium on RADAR-SAT or M-SAT

- Private return will also diverge from social return if there are external economies or diseconomies (externalities). These are costs or benefits created by, but not accruing directly to, the project.

- Taxes and subsidies further distort the market, causing a divergence between social and market prices.

In the presence of such distortions, what then is the interaction between private returns and social return? Of first importance is the fact that the private rate of return based on market prices is the only one we can directly calculate from observed market behaviour. It is the starting point for any estimate of social return. The two elements of any social return on investment calculation are the forecast private return based on observed market prices and costs, and the knowledge of possible distortions which is used to adjust the private return.

Private return is calculated by both private and public officials because it measures the actual costs faced by a firm. Public policy-makers are concerned with social return on investment because it measures the true value of a project to society.

## SOCIAL RATE OF RETURN

Exhibit 12, opposite, shows the social return on investment for the industry and the nation as a whole. Details of the methodology used to calculate these social rates of return are discussed in Appendix B.

The key assumptions in adjusting the firms' private cash flows to calculate the social return on investment were as follows:

- All purchases by government are assumed to represent legitimate needs for which government pays a fair market price (i.e., no price premium).

- Export sales were credited with a premium equivalent to 15% of exports to compensate for the under-valuation of foreign exchange.

# APPENDIX B

## THE CALCULATION OF THE SOCIAL RATE OF RETURN ON INVESTMENT

## THE PERSPECTIVE

As discussed in Chapter V of the report, the private rate of return (in the form of the internal rate of return) considers the returns a project or a company earns for its owners. Along with this private rate of return, the federal government is concerned with the impact of a project on the national economy.

The impact of a project in national income can be judged by comparing the actual, direct productivity of the resources used in the project with the benefits they would produce in alternative uses. Alternative uses are defined as the investment of an equal amount of capital in a "normal" private endeavour which yields an average rate of return to society, and the use of the labour involved in the project compared to the use that appears most likely in the absence of the project. The costs and benefits flowing from the resources employed in the project under review are then compared to the costs and benefits the resources would have produced had they been employed in alternative uses.

The average social yield in Canada has been calculated to be approximately 10 per cent.[1] This rate in the form of a discount rate is, therefore, the rate against which projects are measured. Projects which have a negative net present value when measured against a 10 per cent discount rate, by definition, do not yield a rate of return equal to that which the resources would have yielded had they been employed elsewhere in the economy.

This does not necessarily mean that such projects should not be undertaken. It may well be that equity or other non-quantifiable considerations justify the projects going ahead. It should be clear, however, that there is a quantifiable economic cost to Canada of undertaking such projects. If, on the other hand, a project yields a positive net present value at the 10 per

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[1] Glenn P. Jenkins, Analysis of Rates of Return from Capital in Canada, Ph.D. Thesis, University of Chicago, 1972, unpublished.

cent discount rate, it indicates that the project yields returns greater than the resources employed would have carried had they been left to their next best use.

## CALCULATION OF SOCIAL NET PRESENT VALUE

There are two sets of prices (costs) that can be used to evaluate investment projects. The first is the set of prices determined in the market and known as market prices. An evaluation of a project or company using these prices (for output, materials used, labour employed, etc.) provides us with the private rate of return for the project. These prices may differ from the prices that can be derived from a consideration of social welfare and society's overall resource position, which we call shadow or social prices. The adjustments made to the resource flows based on market prices and included in the private rate of return calculation needed to convert those flows for a social rate of return calculation are discussed in the following sections.

### Revenues

The revenues of the space industry included in our analysis are the sales forecasts of each of the six companies under each of the three procurement scenarios. Our basic assumption is that all of the sales are sales to customers who are paying a price for the goods no greater than what they are worth. In the case of sales to commercial customers, this assumption is almost axiomatic.

In the case of sales to the Canadian government, it is open to question. The government may be purchasing items simply to provide work for certain companies or to support their research and development activities. This would be true if the government did not have a legitimate requirement for all of the goods and services purchased. In such an instance, it would be necessary to deflate the companies' revenues (or alternatively increase the social costs of the project) to account for what would, in essence, be a government subsidy.

Based upon our discussions with departmental officials, it has been decided that all sales to the Canadian government represent goods for which the government has a legitimate need and would procure even in the absence of a Canadian supplier. The only exception to this made for a single company is approximately $4 million in purchases from SPAR Aerospace in 1981. Both company and government officials agree that the primary purpose of these purchases was to sustain the prime contractor capability of Spar in the absence of new satellite orders. Other government purchases such as Anik-C and D where a premium is known to exist, we have deducted as social costs to the industry as a whole, but not to specific companies.

A second possible divergence between market prices and social prices in project revenues would occur if the Canadian government were paying more to meet their procurement requirements in Canada than they would have to pay to obtain the same goods elsewhere. We have assumed that this is not the case except for the procurement of RADAR-SAT and M-SAT where the effects of a purchase price 10, 20 and 30 per cent higher than the cost of purchasing a foreign product have been calculated.

## The Social Valuation of Foreign Exchange

A large portion of the output of the six companies is sold in foreign markets. The remainder is sold to Canadian commercial and governmental customers. Most, if not all, of the Canadian portion of sales would have to be imported in the absence of the Canadian supplier. We have, therefore, considered all of the sales to be either exported or replacing imports that would otherwise have occurred. The sales result, therefore, in foreign exchange being generated.

In an undistorted foreign exchange market, the social valuation of the foreign exchange is most appropriately measured by the market rate. The existence, however, of tariffs, export subsidies and indirect taxes creates a divergence between the market price and the social price of foreign exchange. To calculate the social return on investment, this gap must be determined and the results incorporated in the analysis.

The extent of the gap between the market and the social price of foreign exchange has been estimated by Dr. G.P. Jenkins of Harvard University to be 15 per cent.[1] Bearing in mind that the results of his study yield a point estimate for the gaps, the rate of 15 per cent has been used in the calculations, on the assumption that the overall averaged effect of distortions will not change significantly over the next ten years.

## Project Costs

The major project costs as measured by the market prices include the cost of materials purchased, other goods and services purchased and labour used in the project. To the extent that equipment, materials, or other goods and services purchased are secured abroad and utilize foreign exchange, we have adjusted the market price by 15 per cent to reflect the social price of foreign exchange as discussed above.

## The Social Opportunity Cost of Labour

The impact of a project on labour is always of great interest and importance. This effect could be measured in several different ways including the following:

- Gross jobs created.
- Net jobs created.
- The value Canadians attach to the net jobs created.

It is not possible to characterize any of the above measurement approaches as right or wrong. Some are, however, more meaningful than others. For the

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[1] Jenkins, G.P. Theory and Estimation of the Social Cost of Foreign Exchange Using a General Equilibruim Model With Distortions in Markets. Development Discussion Paper # 28, Cambridge Mass., Harvard University.

purposes of a social return on investment calculation, the value Canadians attach to the net jobs created or the social opportunity cost of labour (SOCL) is the most meaningful measure.

The SOCL is, in essence, labour's value in its next best use. All labour has alternatives. For labour employed in the space industry, it could be employment elsewhere in the high technology industries, in another industry, or simply in the involuntary leisure of the unemployed. The fact that unemployed workers do place a value on their leisure is evidenced by the observation tht the unemployed normally have a positive supply price (it takes a wage offer considerably greater than zero to induce an unemployed worker - even one receiving no unemployment or welfare benefits) to accept a job.

If the actual opportunity cost of labour is less than the wage bill (as would be the case if significant numbers of the workers now employed would otherwise be unemployed), then an adjustment to the market price of the wage bill is necessary to reflect labour's social price. On the other hand, it is possible for the social price of labour to exceed the wage bill. This would be the case if all the labour employed in a project would have otherwise been employed in projects of at least equal value. In such a situation, the private sector wage bill would be increased to reflect such items as additional hiring costs imposed on other employers who lose employees to the new project.

In our social return on investment calculation for the space industry, we have allowed a labour benefit equal to 10 per cent of the wage bill. This implies that at least 10 per cent of the workers employed in the space industries would have otherwise been unemployed. We regard this adjustment as being the maximum that should be made and, in fact, it probably overstates the labour benefits of the industry. We base this conclusion on several pieces of supporting evidence:

- in a 1977 study for the Economic Council of Canada, G.P. Jenkins estimated the overall general SOCL in Canada to be 95 per cent of the private wage bill[1]. This implies a labour benefit of 5 per cent

- in an unpublished paper for York University, J.C. Evans concluded that, in general, new jobs created by projects cause only a reasonably small and temporary reduction in the number of unemployed[2]

- our discussions with the six companies indicated that shortages of workers with the types of skills needed in the space industry are a critical, if not the critical, problem in the industry. Few, if any, unskilled workers are used and most have advanced training. For example, one company indicates that out of a total staff of approximately 200, 20 - 25 have Ph.D's, 50 have Masters' Degrees and 60 are Bachelors of Engineering. Their total production staff was 11. In such a case, it is highly unlikely that any of the workers employed would be otherwise unemployed.

It should be emphasized that the determination of social opportunity cost requires the analysis of a dynamic process (individuals moving into and out of employment over time). As a result of time and resource constraints, we have not carried out such a dynamic analysis. The results of such an analysis could very well indicate that a labour penalty rather than a labour benefit should be applied to projects in the space industry. For future analysis of space-related projects, the Department may wish to undertake such a study.

Foreign Exchange and Sales Tax
Foregone on Labour Employed

As noted above, for the purposes of this analysis, we have assumed that 90 per cent of the labour employed by the six space industry companies would

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[1] Jenkins, G.P. Capital in Canada; its Social and Private Performance 1965 - 1974 Discussion Paper #98, Ottawa, Economic Council of Canada, 1977.

[2] Evans, J.C. Estimation of Labour Response Function For Canada, unpublished, York University.

have been employed elsewhere. In this alternative employment some of them would have been producing products which would have earned foreign exchange and sales tax. By employing them in the space industry, we are foregoing that foreign exchange and sales tax. The extent of this benefit foregone has been estimated at 4 per cent of that portion (90 per cent) of the wage bill estimated to represent workers who would otherwise have been unemployed.

## Government Contributions Toward Research and Capital Expenditures

The companies' expenditures on research and development and for capital expenditures are, of course, included as part of the private cash flow and hence part of the material cost of undertaking work in the space industry. To the extent that additional government support is provided as grants (aside from development contracts for specific research projects which, as discussed above, we have considered to be ordinary government procurement) there is an additional cost to the nation. Amounts of government assistance as anticipated by each company have been included in our social return on investment calculation for each company. Other programs which relate to support for the industry as a whole have been valued and applied to the aggregate results.

## Opening and Closing Values for the Assets Employed in Space-Related Business

In order to calculate a return on investment (either social or private), it is necessary to value the assets committed to the company or the project at the beginning of the project. This valuation should be the opportunity costs of the relevant assets (i.e., their value in their next best use). For a social return on investment calculation, the normal practice is to calculate the value of the physical assets employed - the fixed investment in plant and equipment and the inventory. This is, in fact, what we have done in this case. Each company estimated the portion of their physical assets utilized in the space industry and this value was charged to the project in the beginning of 1981. In addition, for the industry as a whole, we have estimated the value of the David Florida Laboratory and included this in the calculation. Similarly, the value of the assets at the end of the time period under consideration must be credited to the project. We have therefore estimated the value of the inventory and fixed assets on hand in 1990.

The approach we have used is a standard part of the methodology used for analysing industrial projects. A characteristic of the space industry, however, is that firms utilize relatively little physical capital in relation to the value of sales generated. They are, rather, knowledge- or technology-intensive. Their most important assets, whether at the beginning or the end of a project, are probably not plant, equipment, and inventory, but their technological capability. Conceptually, the opening value of this capability should be charged to the project at the beginning of the time period and the closing value credited at the end. The value would be the future cash flow attributable to the technology. The techniques to make this adjustment do not at present exist.

Corporate Income Taxes

From the private owner's point of view, taxes paid to the government are an expense. From the point of view of society, this is not the case. The taxes are rather a distribution of the benefits of an industrial project. They are, in theory, utilized by the government to provide the social goods and services people have elected to consume collectively through the political process rather than privately through market transactions. If the private cash flow is in after tax dollars, the taxes paid are a social benefit to the project. In the particular case of the space industry, we have done all the calculations in before tax dollars, and this adjustment has not been necessary.

## The Discount Rate

When the market prices for revenues and expenses have been adjusted to social prices, it is necessary to calculate the net value of social revenues and expenses for the social return on investment. The major difficulty in making this comparison is that simple addition would neglect the time element, i.e., expenses may occur earlier than benefits. It is necessary to place the streams of future revenues and expenses in a common denominator. This is accomplished by means of a discount rate. By the process of discounting, revenues and expenses accruing at different times are revalued to make them comparable to present values. These amounts can then be added to give a single figure which expresses the social net present value of a project.

The selection of an appropriate discount rate is critical. The basic principle that must be followed to ensure that a project does not ultimately retard the national level of economic output is that it must produce a rate of return equal to the full before tax rate of return that is foregone.

As noted earlier, we have selected a real rate of 10 per cent (no inflation) for the purposes of analysing investment in the space industry. This represents the opportunity cost of funds available to the federal government and hence is a composite of the rates of return earned in the uses from which it is assumed such funds are drawn. This is the rate generally utilized for government-assisted projects.

The majority of the funds utilized by the space industry, however, do not necessarily have as their next best alternative the general average rate of 10 per cent. It is possible that their next best alternative is some other high technology industry which probably yields a rate of return much higher than 10 per cent (for example, for all manufacturing, the social yield - before all taxes but net of inflation - was 13.18 per cent in the period 1965 - 1974).[1] The use of a higher discount rate, while probably not affecting the positive outcome of the space industry, would certainly result in a smaller level of benefits.

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[1] G.P. Jenkins Capital in Canada: Its Social and Private Performance 1965 - 1974 (Ottawa: Economic Council of Canada Discussion Paper No. 98) 1977 pg. 39 and 43.

Multipliers

The multiplier concept applies when an increase in aggregate demand can lead to an incremental increase in total output, income, or employment by drawing previously underutilized resources into production. When general underutilization prevails and the only leakage is into savings, the multiplier may be high. When no underutilization prevails, the multiplier will be one which means that a new project will not raise income or create additonal jobs; it just pushes prices and wages up.

We have assumed that the latter situation prevails regarding investments in the Canadian space industry, and therefore have not included any multiplier effect in the analysis. We have adopted this approach for several reasons:

- No general underutilization of capital or labour prevails.
- A high multiplier would require a low leakage of expenditures into savings and imports. High technology projects typically require large amounts of imported materials.
- For a previous study of high technology projects done for the Department, Dr. Jenkins of Harvard University estimated the maximum multiplier to be only around 1.1.

Summary

In summary, the social net present value for investment in the space industry has been calculated by first charging the project with the opening value of the physical assets committed to the space industry, then on a yearly basis adjusting the forecast private cash flows of each company's space business to reflect the social value of the foreign exchange generated, labour employed, government assistance, etc., and finally crediting the estimated final value of the physical assets remaining in 1990. All values are discounted to the beginning of 1981 using a 10 per cent discount rate.

Industry-wide values are calculated by summing the company values and adjusting the totals for subsidies relevant to the entire industry, such as L-SAT expenditures and the cost of the David Florida Laboratory. The result for each of the three procurement scenarios is a social net present value. The value of each separate procurement program can be calculated by subtracting the net present value of the base case plus RADAR-SAT and the base case plus RADAR-SAT and M-SAT.

## APPENDIX C

## DETAILED FINANCIAL RESULTS

- SPAR Aerospace Limited
- SED Systems Inc.
- MacDonald, Dettwiler and Associates Ltd.
- Com Dev Ltd.
- Miller Communication Systems Ltd.
- Canadian Astronautics Limited

EXHIBIT C-3

SPAR AEROSPACE

DETAILED RESULTS

BASE CASE PLUS RADAR-SAT PLUS M-SAT

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales - Domestic | 35.6 | 68.5 | 83.3 | 113.4 | 134.4 | 147.5 | 160.6 | 173.8 | 186.9 | 200.1 |
| - Export | 43.6 | 52.7 | 54.7 | 62.5 | 72.1 | 84.9 | 97.7 | 110.5 | 123.3 | 136.1 |
| Total | 79.2 | 121.2 | 138.0 | 175.9 | 206.5 | 232.4 | 258.3 | 284.3 | 310.2 | 336.2 |
| Net Cash Flow* | 1.5 | 3.8 | 7.9 | 15.1 | 23.9 | 28.5 | 31.9 | 35.3 | 38.7 | 42.2 |
| Gross R&D | 3.0 | 5.1 | 6.9 | 9.8 | 12.8 | 14.4 | 16.0 | 17.5 | 19.1 | 20.7 |
| Number of Employees | 1,094 | 1,456 | 1,679 | 1,987 | 2,287 | N.A. | N.A. | N.A. | N.A. | 3,681 |

*Excluding Interest

N.A. Detailed Estimate Not Available

EXHIBIT C-2

SPAR AEROSPACE

DETAILED PROJECTIONS

BASE CASE PLUS RADAR-SAT

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ($'Million 1981) | | | | | |
| Sales - Domestic | 34.1 | 44.0 | 68.4 | 77.7 | 72.8 | 79.7 | 86.6 | 93.6 | 100.5 | 107.4 |
| - Export | 43.6 | 51.1 | 52.4 | 57.8 | 66.5 | 76.9 | 87.3 | 97.7 | 108.1 | 118.5 |
| Total | 77.7 | 95.1 | 110.8 | 135.5 | 139.3 | 156.6 | 173.9 | 191.3 | 308.6 | 225.9 |
| Net Cash Flow* | 1.6 | 3.0 | 5.4 | 8.8 | 11.7 | 13.2 | 15.0 | 16.9 | 18.7 | 20.6 |
| Gross R&D | 2.8 | 3.6 | 4.9 | 5.6 | 5.8 | 6.8 | 7.5 | 8.2 | 9.0 | 9.7 |
| Number of Employees | 1,083 | 1,210 | 1,468 | 1,570 | 1,610 | N.A. | N.A. | N.A. | N.A. | 2,588 |

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*Excluding Interest

N.A. Estimate Not Available

EXHIBIT C-1

SPAR AEROSPACE

DETAILED RESULTS

BASE CASE

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ($'Millions 1981) | | | | | |
| Sales - Domestic | 28.6 | 33.0 | 26.3 | 27.3 | 27.8 | 34.6 | 41.2 | 47.8 | 54.4 | 61.0 |
| - Export | 43.6 | 50.1 | 50.3 | 54.4 | 59.2 | 68.2 | 77.2 | 86.2 | 95.2 | 104.2 |
| Total | 72.2 | 83.1 | 76.6 | 81.7 | 87.0 | 102.8 | 118.4 | 134.0 | 149.6 | 165.2 |
| Net Cash Flow* | 1.5 | 2.6 | 2.1 | 3.7 | 5.4 | 6.1 | 7.1 | 8.1 | 9.1 | 10.0 |
| Gross R&D | 2.4 | 2.6 | 2.6 | 3.0 | 3.7 | 4.5 | 5.1 | 5.8 | 6.5 | 7.1 |
| Number of Employees | 1,040 | 1,094 | 1,063 | 1,044 | 1,062 | N.A. | N.A. | N.A. | N.A. | 2,027 |

*Excluding Interest

N.A. Estimate Not Available

# SPAR AEROSPACE LIMITED

The accompanying Exhibits, C-1, C-2 and C-3, opposite, show the yearly sales, cash flows, research and development and employment for SPAR under each of the three procurement strategies. These figures, based on data supplied to us by the company, are essentially the activities included in the SPAR Space and Electronic Group, less those of the Defence Systems Division. The following product lines are included:

- satellite systems
- satellite subsystems
- products for use in space systems (either satellite or RMS)
- space remote manipulators and supporting hardware
- ground remote manipulator systems
- communications systems and related products.

## IMPACT OF ALTERNATIVE GOVERNMENT EXPENDITURE LEVELS

SPAR Aerospace would be a major beneficiary should the Canadian government elect to proceed with RADAR-SAT or RADAR-SAT and M-SAT. Overall results, both private and social, for the company are shown in Exhibit C-4, overleaf. As this exhibit indicates, the effect of achieving prime contract status on a RADAR-SAT would be to raise SPAR's internal rate of return (IRR) from 36% to 53%. The social net present value of the company's operations increases by $51.5 million, from $104.4 million to $155.9 million. The addition of an M-SAT program (or any similar program such as DBS) would raise the IRR to 70% and the social net present value an additional $85.4 million.

EXHIBIT C-4

SPAR AEROSPACE LIMITED

FINANCIAL AND ECONOMIC RESULTS

| | Private Internal Rate of Return | Social Net Present Value |
|---|---|---|
| | (%) | ($ million 1981) |
| Base Case | 36 | 104.4 |
| Base and RADAR-SAT | 53 | 155.9 |
| Base, RADAR-SAT and M-SAT | 70 | 241.3 |

SPAR indicated that their forecasts are optimistic in that they are what the company hopes would happen with regard to profit margins under each of the three scenarios.

The company's general market and financial assumptions underlying the results of each of the scenarios are described below.

Base Scenario

- No new satellite prime contracts are undertaken before 1985.
- As a result, the Satellite Systems Divison has only study work plus L-SAT assembly, integration and testing after the completion of Anik-D in mid-1982.
- With no new satellite starts, the payload technology in the Aerospace Division will become obsolete, and market penetration will erode rapidly, so that market share will be effectively zero past 1985.
- Few operating efficiency improvements will be practical, except in the communications systems area.
- Research and development activities alone will not maintain the technological competitiveness of payload work.
- A significant risk exists that a future of declining business will erode staff confidence and a further decline in capability will steepen the business decline.

Base Plus RADAR-SAT

- A RADAR-SAT program starts with the research and development phase in October, 1981, and continues for six years. Program value to SPAR for the space segment only is $155 million ($1981) for one flight model and a qualification model that can be refurbished. No government costs are included. SPAR assumes that the program would be all-Canadian, but would contain significant sub-contracts from SPAR to US sources for bus hardware and subsystems.
- The RADAR-SAT start will give the Aerospace Division sufficient technological impetus to maintain the 1981 level of sales constant to 1985.

- Some operating efficiencies can be achieved during the period as well as some increases in research and development expenditures and in profitability.
- Capital expenditures cover capability maintenance as well as the specific expenditures necessary to test the RADAR-SAT payload. Other elements of the business regarding capital expenditures remain unchanged from the base case scenario.
- The cost estimate of the RADAR-SAT program is based on a 1980 study by Canadian Astronautics Limited. Estimates of program content were based generally on Anik-D estimates.

Base Plus RADAR-SAT plus M-SAT

- An M-SAT program starts in October, 1981, and continues through 1986. The program is designed primarily to meet DND needs and costs $221.0 million ($1981 constant), based on a factor of 1.5 times the RADAR-SAT cost. The program is all-Canadian but contains significant sub-contracts from SPAR to the US for bus hardware and subsystems and specialized payload components. No government costs are included.
- A RADAR-SAT program is carried out as in the previous scenario but with a start of the research and development phase in October, 1982.
- The technological synergy created by this scenario will allow the Aerospace Division to increase sales over the period and to enter new markets such as the US defence contractor market. Capital and research and development expenditures would be increased to support this growth.
- A major capital allocation in 1982 and 1984 is made to permit consolidation of space activities so that significant operating efficiencies can be achieved. Government capital assistance is assumed for this allocation.

Other Assumptions

In addition, the following assumptions were made in preparing SPAR's sales forecast:

- The L-SAT Solar Array and AI&T programs are carried as export sales at full value.

- The follow-on program of SAR-SAT receivers is carried at full value.
- Ground communications is a growth market independent of other elements, as is ground RMS.
- Space RMS is a stable market in the 1981-85 period.
- No new major RMS design development programs will take place before 1985.

SPAR indicated that overall company profitability and cash flow are insensitive to volume for two major reasons:

- Direct costs are not strictly related to volume and are, in fact, substantially fixed. This results from the fact that the labour force in a high technology environment cannot be increased or decreased to match volume changes.
- Indirect costs cannot be easily altered to match variations in business volume in the short-term.

The company indicated that the profit margins attainable in the space and space-related business areas are highly dependent on the market, the customer, and the amount of development work involved in each particular job. Few products are produced in large volumes. The margins achieved on space-related business do not vary significantly from those achieved in the company's other aerospace business.

# EXHIBIT C-5

## SED SYSTEMS INC.

## DETAILED RESULTS

## BASE CASE

($'Millions 1981)

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales - Domestic | 6.6 | 9.2 | 11.9 | 12.6 | 15.8 | 19.4 | 22.8 | 25.9 | 28.4 | 30.9 |
| - Export | 4.3 | 7.7 | 12.8 | 20.7 | 27.7 | 34.2 | 40.5 | 46.2 | 50.9 | 56.0 |
| Total | 10.9 | 16.9 | 24.7 | 33.3 | 43.5 | 53.6 | 63.3 | 72.1 | 79.3 | 86.9 |
| Net Cash Flow* | (.4) | (.6) | (.7) | (.6) | (.5) | .6 | 1.3 | 2.0 | 2.7 | 3.2 |
| Gross R&D | .5 | .8 | 1.2 | 1.7 | 2.2 | 2.7 | 3.1 | 3.6 | 3.9 | 4.3 |
| Number of Employees | 160 | 240 | 340 | 440 | 545 | 640 | 720 | 785 | 820 | N.A. |

*Excluding Interest

N.A. Estimate Not Available

## SED SYSTEMS INC.

Exhibit C-5, opposite, gives the detailed results for SED Systems Inc. As discussed below, only one scenario was prepared by SED Systems. The gross forecast sales for the years 1981-1989 are based upon:

- internal forecast sales between 1981 and 1985
- a trend-line analysis of the 1981 to 1985 figures to derive the forecasts for 1986-1990.

These gross forecast sales were viewed by senior management of SED as being unrealistically high because many of the space programs require government policy and/or funding decisions and because of possible difficulties in obtaining qualified manpower. SED also factored in its desire to proceed at a controlled growth rate. As the figures indicate, the result is still a rapid growth in sales.

With regard to profit margins in different types of work, the company indicated that they currently have no fixed/variable costing system; thus determining the profit impact of changes in volume is difficult. The majority of their space-related sales are, however, in the ground segment which, because they represent manufactured goods, are susceptible to volume efficiencies. Margins on these products are in the neighbourhood of 12-15 percent. The remainder of their sales represent project work which is almost all labour and the margins do not improve with greater volume. Although there is some learning curve effect, any such benefits may be given away in the form of lower prices to obtain the business.

### IMPACT OF ALTERNATIVE GOVERNMENT EXPENDITURE LEVELS

The forecast results for SED Systems for the base scenario are shown in Exhibit C-6, overleaf. The projections for SED include no business

EXHIBIT C-6

SED SYSTEMS INC.

FINANCIAL AND ECONOMIC RESULTS

| | Private Internal Rate of Return (%) | Social Net Present Value ($ Millions 1981) |
|---|---|---|
| Base Scenario | 22 | 41.8 |

specifically related to the RADAR-SAT or M-SAT programs. The company indicated that it could not forecast what level of business it might receive from either of these two programs. Management stated that they have been approached with regard to the possibility of being the prime contractor in the M-SAT program, but as we have included the prime contractor business in the forecasts for SPAR Aerospace, we have not included them here.

The company's projections do assume that Direct Broadcasting System (DBS) TV systems will be in place in Canada in the near future. They indicated, however, that it is the world market in which they expect to achieve the bulk of their business. They believe that, even in the absence of a significant domestic market, a contractual arrangement with General Instruments will allow them to achieve a significant volume of business from this product.

The agreement with General Instruments gives General Instruments the right to sell in Canada as well as in the rest of the world. SED indicated that they are, in effect, giving the high-volume mass market to General Instruments and that they themselves will concentrate on the specialist applications. They do not believe they have the capability to handle the mass market items on their own.

EXHIBIT C-8

MACDONALD DETTWILER & ASSOCIATES LTD.

BASE CASE PLUS RADAR-SAT

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ($'Millions 1981) | | | | | |
| Sales - Domestic | 2.3 | 2.8 | 4.7 | 6.2 | 6.9 | 16.7 | 12.9 | 13.9 | 15.1 | 16.3 |
| - Export | 9.5 | 12.0 | 13.3 | 15.2 | 20.9 | 27.2 | 37.2 | 50.2 | 67.0 | 89.1 |
| Total | 11.8 | 14.8 | 18.0 | 21.4 | 27.8 | 43.9 | 50.. | 64.1 | 82.1 | 105.4 |
| Net Cash Flow* | (.2) | (.9) | (2.6) | (3.0) | (5.3) | (2.9) | (3.9) | (4.3) | (6.1) | (6.8) |
| Gross R&D | 1.2 | 2.2 | 2.8 | 3.3 | 4.2 | 6.6 | 7.4 | 9.6 | 12.2 | 15.7 |
| Number of Employees | 162 | 203 | 250 | 290 | 417 | 533 | 683 | 876 | 1,123 | N.A. |

*Excluding Interest

N.A. Estimate Not Available

EXHIBIT C-7

MACDONALD DETTWILER & ASSOCIATES LTD.

DETAILED RESULTS

BASE CASE

($'Millions 1981)

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales - Domestic | 2.4 | 2.8 | 4.7 | 6.2 | 6.9 | 8.2 | 8.5 | 9.5 | 9.8 | 10.2 |
| - Export | 9.5 | 12.0 | 13.3 | 15.1 | 17.9 | 20.1 | 24.4 | 29.4 | 37.0 | 46.2 |
| Total | 11.9 | 14.8 | 18.0 | 21.3 | 24.8 | 28.3 | 32.9 | 38.9 | 46.8 | 56.4 |
| Net Cash Flow* | .3 | .6 | .5 | .9 | 1.3 | 1.4 | 1.5 | 2.7 | 2.4 | 2.9 |
| Gross R&D | 1.2 | 1.7 | 2.2 | 2.2 | 1.9 | 2.7 | 3.5 | 4.2 | 6.0 | 7.2 |
| Number of Employees | 143 | 179 | 220 | 257 | 300 | 344 | 400 | 441 | 530 | N.A. |

*Excluding Interest

N.A. Estimate Not Available

# MACDONALD, DETTWILER AND ASSOCIATES LTD. (MDA)

The accompanying exhibits C-7 and C-8 illustrate the financial results for MDA under the base scenario and under the base plus RADAR-SAT scenario. The following are the basic market assumptions on which the results are based.

- The US government has no commitment to the LANDSAT Program beyond LANDSAT-D, to be launched in approximately 1985.
- The Canadian government and other countries with MDA-supplied international LANDSAT ground stations proceed with LANDSAT-D upgrades and MSS data but no Thematic Mapper.
- MDA exploits the Airborne SAR processor business commercially in Canada and in the international market place.
- A RADAR-SAT would mean that ground stations are required, including one by the Canadian government for Resolute Bay. After developing that technology in Canada, MDA would then proceed to exploit the technology in foreign markets.

## IMPACT OF ALTERNATIVE GOVERNMENT EXPENDITURE LEVELS

Exhibit C-9, overleaf, shows the financial and economic results for McDonald, Dettwiler and Associates. As the exhibit indicates, the results apparently show a negative impact on the company of participating in the RADAR-SAT program. We believe this to be a result of a methodological problem in preparing the numbers rather than a reflection of the actual situation.

MDA assumes that with a RADAR-SAT program they will do a lot of the basic ground technology and some work in the area of ice monitoring. It is their intention to exploit this technology in foreign markets. In this situation

EXHIBIT C-9

MACDONALD, DETTWILER AND ASSOCIATES LTD.

FINANCIAL AND ECONOMIC RESULTS

| | Private Internal Rate of Return (%) | Social Net Present Value ($ Million 1981) |
|---|---|---|
| Base Case | 60 | 20.7 |
| Base Case and RADAR-SAT | negative | (5.1) |
| Base Case, RADAR-SAT and M-SAT | negative | (5.1) |

they would invest increasing amounts of capital in the business: both in the form of fixed assets and working capital and in research and development. As a result, the forecasts for this scenario do not show the company generating a positive cash flow. Under the methodological assumptions used in calculating the rate of return, the company is credited only with the value of the physical assets as they exist in 1990 and not with the potential future cash flows derived from the technological position of the firm as it would then presumably be.

EXHIBIT C-12

COM DEV

DETAILED PROJECTIONS

BASE CASE PLUS RADAR-SAT PLUS M-SAT

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ($' Millions 1981) | | | | | |
| Sales - Domestic | 1.1 | 1.4 | 2.1 | 2.6 | 3.3 | 3.9 | 4.7 | 5.7 | 6.6 | 7.6 |
| - Export | 3.5 | 4.6 | 5.7 | 7.1 | 8.8 | 10.7 | 12.8 | 15.3 | 18.0 | 20.6 |
| TOTAL | 4.6 | 6.0 | 7.8 | 9.7 | 12.1 | 14.6 | 17.5 | 21.0 | 24.6 | 28.2 |
| Net Cash Flow* | (0.2) | 0.2 | 1.0 | 1.3 | 2.1 | 2.8 | 3.3 | 4.1 | 5.2 | 7.0 |
| Gross R&D | 0.7 | 0.8 | 0.9 | 1.1 | 1.4 | 1.8 | 2.1 | 2.5 | 3.0 | 3.4 |
| Number of Employees | 95 | 124 | 160 | 200 | 250 | N.A. | N.A. | N.A. | N.A. | N.A. |

*Excludes Interest

N.A. Estimate Not Available

EXHIBIT C-11

COM DEV

DETAILED PROJECTIONS

BASE CASE PLUS RADAR-SAT

($' Millions 1981)

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales - Domestic | 1.1 | 1.4 | 2.1 | 2.0 | 2.6 | 3.3 | 4.1 | 4.9 | 5.7 | 6.6 |
| - Export | 3.5 | 4.6 | 5.7 | 5.5 | 6.9 | 8.9 | 11.1 | 13.3 | 15.6 | 17.9 |
| TOTAL | 4.6 | 6.0 | 7.8 | 7.5 | 9.5 | 12.2 | 15.2 | 18.2 | 21.3 | 24.5 |
| Net Cash Flow* | (0.2) | 0.2 | 1.0 | 0.8 | 1.5 | 1.9 | 2.7 | 3.6 | 4.5 | 6.0 |
| Gross R&D | 0.7 | 0.8 | 0.9 | 0.9 | 1.1 | 1.4 | 1.8 | 2.2 | 2.6 | 2.7 |
| Number of Employees | 95 | 124 | 160 | 200 | 250 | N.A. | N.A. | N.A. | N.A. | N.A. |

*Excludes Interest

N.A. Estimate Not Available

EXHIBIT C-10

COM DEV

DETAILED PROJECTIONS

BASE CASE

($' Millions 1981)

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales - Domestic | 1.1 | 1.4 | 1.7 | 1.4 | 1.9 | 2.8 | 3.4 | 4.0 | 4.7 | 5.5 |
| - Export | 3.5 | 4.6 | 4.5 | 3.9 | 5.0 | 7.6 | 9.1 | 11.0 | 12.8 | 14.7 |
| TOTAL | 4.6 | 6.0 | 6.2 | 5.3 | 6.9 | 104 | 12.5 | 15.0 | 17.5 | 20.2 |
| Net Cash Flow* | (0.2) | 0.2 | 0.6 | 0.2 | 0.8 | 1.4 | 2.4 | 2.9 | 3.7 | 4.9 |
| Gross R&D | 0.7 | 0.8 | 0.7 | 0.6 | 0.8 | 1.2 | 1.5 | 1.8 | 2.1 | 2.4 |
| Number of Employees | 95 | 124 | 160 | 200 | 250 | N.A. | N.A. | N.A. | N.A. | N.A. |

*Excludes Interest

N.A. Estimate Not Available

# COM DEV LTD.

The business forecasts supplied by Com Dev are summarized in Exhibits C-10, C-11 and C-12, opposite. These forecasts are based on the submission made by Com Dev, dated June 23, 1981, to PMP for this study. Subsequently, Com Dev submitted a revised forecast which adjusted certain cost elements.

The effect of these changes would be to increase the gross operating margin on Com Dev's sales by a substantial amount, especially in the early years, and hence increase Com Dev's return on investment. However, since these changes are not thought to affect the total industry's return and due to time constraints, the revisions have not been analyzed and incorporated in the study's results.

Com Dev prepared its forecast on the assumption that government's major satellite program would be as follows:

- L-SAT beginning in late 1981 for which it would expect sales of $3.5 million
- an interim DBS program beginning late 1982, involving sales of $2.0 million for Com Dev
- either RADAR-SAT or M-SAT in the period 1983-87, each with $12.0 million of sales
- DBS beginning later (1984 or 1985) accounting for sales of $15 million.

In effect, Com Dev anticipates that a version of Case 3 will be realized.

In order to construct the three scenarios for the study, estimated expenditures on each of the satellite programs were deducted from Com Dev's total sales. This excludes the option that Com Dev would likely have of substituting foreign sales for the "assumed" government expenditures.

Com Dev expects that its contribution to the proposed space program would be in the area of satellite input and output multiplexor networks and certain earth station components and subsystems. It also anticipates that it will expand its product line to include Surface Acoustic Wave (SAW) devices which would be used in RADAR-SAT, M-SAT and defence surveillance programs.

Other key assumptions in Com Dev's forecast are as follows:

- exports continue to constitute the major part of Com Dev's business
- equipment has a foreign exchange content of about 50% and materials about 35%
- net R&D expenditure would amount to about 6-7% of sales. However, government assistance would be sought for at least equivalent amounts
- considerable capital investment (about $2.0 million in plant and $4.3 million in equipment) would be undertaken in the period 1981-85 (mainly for SAW production) for which government capital assistance of about $1.3 million would be requested.

Com Dev is currently operating at virtually full capacity and must continue to expand both its staff and facilities to keep pace with its increasing sales. Labour could be a constraint; however, Com Dev reduces its labour supply difficulties by training inexperienced university graduates. About half of Com Dev's staff are engineers, scientists, and skilled technologists.

Com Dev's marketing strategy has been to exploit its technological capability in particular areas and hence be an alternative or single source supplier of components for the major aerospace companies (largely in the United States). It has done so successfully for a number of years and in the future it hopes to expand its product base. Government support in achieving this goal by offering Com Dev (and other Canadian companies) opportunities to provide innovative products that lead to commercial applications in future years is critical. This

EXHIBIT C-13

COM DEV

FINANCIAL AND ECONOMIC RESULTS

| | Private Internal Rate of Return (%) | Social Net Present Value ($ million 1981) |
|---|---|---|
| Base Case | 33 | 12.9 |
| Base Case and RADAR-SAT | 30 | 15.7 |
| Base Case, RADAR-SAT and M-SAT | 44 | 20.5 |

could happen under L-SAT for which Com Dev would develop advanced multiplexing capabilities and under M-SAT or RADAR-SAT for which Com Dev hopes to develop new SAW technology.

## IMPACT OF ALTERNATIVE GOVERNMENT EXPENDITURE LEVELS

Exhibit C-13, <u>opposite</u>, presents the results for Com Dev calculated for the three scenarios. It can be seen that Com Dev in general expects a high return from its activities - from 33% to 44% depending on the scenario. Its contribution to the industry's social return could vary between $12.9 million and $20.5 million.

EXHIBIT C-14

MILLER COMMUNICATIONS SYSTEMS

DETAILED PROJECTIONS

BASE CASE

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| | ($' Millions 1981) | | | | | | | | | |
| Sales - Domestic | 0.9 | 1.3 | 1.7 | 2.3 | 3.1 | 4.2 | 5.7 | 7.7 | 10.5 | 14.3 |
| - Export | 0.9 | 1.2 | 1.6 | 2.2 | 3.0 | 4.2 | 5.6 | 7.7 | 10.5 | 14.3 |
| TOTAL | 1.8 | 2.5 | 3.3 | 4.5 | 6.1 | 8.4 | 11.3 | 15.4 | 21.0 | 28.6 |
| Net Cash Flow* | 0.2 | 0.5 | 0.4 | 0.8 | 0.7 | 1.2 | 1.2 | 2.2 | 2.3 | 3.9 |
| Gross R&D | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.6 | 0.8 | 1.1 | 1.4 | 2.0 |
| Number of Employees | 50 | 75 | 100 | 150 | 200 | 250 | 400 | N.A. | N.A. | N.A. |

*Excludes Interest

N.A. Estimate Not Available

MILLER COMMUNICATIONS SYSTEMS LTD.

Miller's business forecast is contained in Exhibit C-14, opposite. Only one forecast was prepared by Miller as it did not perceive its business prospects to depend significantly on possible major government programs.

The forecast prepared by Miller indicates its strategy of seeking a diversified client base. Government, up until recently, has been a major client. However, Miller has been successful in obtaining export contracts in space and defence-related areas. Export contracts currently amount to about 50% of Miller's backlog, up from less than 10% of total sales in 1979. The military market both in the United States and Canada is expected to be Miller's principal area of future business.

No grant assistance from government for space-related activity is assumed in the forecast.

Other key assumptions are as follows:

- sales grow at an average annual rate of 50% in nominal terms. An inflation rate of 10% was assumed to bring Miller's forecast into 1981 constant dollars
- exports amount to 50% of total sales
- major capital investment in new facilities will be necessary about every second year
- the foreign exchange component of Miller's sales is high: 90% of materials and equipment are imported
- R&D support would average 7% of sales, a substantial increase over Miller's current levels
- personnel costs are considerable: equivalent to 60% of sales
- only 55% of the net present value of Miller was credited to the social return of the industry to reflect Miller's decline in space-related business.

EXHIBIT C-15

MILLER COMMUNICATIONS SYSTEMS LTD.

FINANCIAL AND ECONOMIC RESULTS

| | Private Internal Rate of Return (%) | Social Net Present Value ($ million 1981) |
|---|---|---|
| Base Case | 83 | 8.3 |
| Base Case and RADAR-SAT | - | - |
| Base Case, RADAR-SAT and M-SAT | - | - |

## Financial and Economic Results

The private return on Miller's operation is estimated to be very high, as shown in Exhibit C-15, opposite. Since only a portion of Miller's future business is expected to be in space-related areas, an estimated 55% (or $8.3 million) of the social return generated by Miller was credited to the space industry.

EXHIBIT C-18

CANADIAN ASTRONAUTICS LTD.

DETAILED PROJECTIONS

BASE CASE PLUS RADAR-SAT PLUS M-SAT

($' Millions 1981)

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales - Domestic | 2.7 | 4.4 | 6.2 | 8.7 | 11.1 | 14.5 | 18.4 | 24.0 | 31.2 | 40.5 |
| - Export | 3.3 | 5.4 | 7.5 | 10.6 | 13.6 | 17.7 | 22.6 | 29.3 | 38.1 | 49.5 |
| TOTAL | 6.0 | 9.8 | 13.7 | 19.3 | 24.7 | 32.2 | 41.0 | 53.3 | 69.3 | 90.0 |
| Net Cash Flow* | 0.4 | 0.2 | (2.0) | 1.6 | 2.3 | (3.3) | 3.8 | 5.2 | (5.5) | 8.7 |
| Gross R&D | 0.5 | 0.9 | 1.1 | 1.5 | 1.8 | 2.2 | 2.8 | 3.5 | 4.5 | 5.7 |
| Number of Employees | 90 | 135 | 180 | 240 | 300 | 380 | N.A. | N.A. | N.A. | N.A. |

*Excludes Interest

N.A. Estimate Not Available

EXHIBIT C-17

CANADIAN ASTRONAUTICS LTD.

DETAILED PROJECTIONS

BASE CASE PLUS RADAR-SAT

($' Millions 1981)

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales - Domestic | 2.7 | 4.5 | 6.3 | 8.1 | 10.5 | 13.7 | 17.8 | 23.1 | 30.1 | 39.1 |
| - Export | 3.3 | 5.3 | 7.7 | 9.9 | 12.9 | 16.7 | 21.7 | 28.3 | 36.7 | 47.9 |
| TOTAL | 6.0 | 9.8 | 14.0 | 18.0 | 23.4 | 30.4 | 39.5 | 51.4 | 66.8 | 87.0 |
| Net Cash Flow* | 0.4 | 0.2 | (2.0) | 1.5 | 2.2 | (3.5) | 3.6 | 5.0 | (5.8) | 8.4 |
| Gross R&D | 0.5 | 0.9 | 1.0 | 1.2 | 1.5 | 2.0 | 2.5 | 3.2 | 4.1 | 5.3 |
| Number of Employees | 90 | 135 | 180 | 240 | 300 | 380 | N.A. | N.A. | N.A. | N.A. |

*Excludes Interest

N.A. Estimate Not Available

# EXHIBIT C-16

## CANADIAN ASTRONAUTICS LTD.

## DETAILED PROJECTIONS

## BASE CASE

| | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ($' Millions 1981) | | | | | |
| Sales - Domestic | 2.7 | 4.3 | 5.6 | 7.1 | 9.2 | 13.0 | 18.9 | 21.9 | 28.9 | 37.1 |
| - Export | 3.3 | 5.3 | 6.7 | 8.7 | 11.2 | 15.9 | 70.7 | 26.9 | 34.9 | 45.4 |
| TOTAL | 6.0 | 9.6 | 12.3 | 15.8 | 20.4 | 28.9 | 39.6 | 48.8 | 63.8 | 82.5 |
| Net Cash Flow* | 0.4 | 0.2 | (2.1) | 1.2 | 1.8 | (3.8) | 3.3 | 4.7 | (6.2) | 7.8 |
| Gross R&D | 0.5 | 0.9 | 1.0 | 1.2 | 1.5 | 2.0 | 2.5 | 3.2 | 4.1 | 5.3 |
| Number of Employees | 90 | 135 | 180 | 240 | 300 | 380 | N.A. | N.A. | N.A. | N.A. |

*Excludes Interest

N.A. Estimate Not Available

# CANADIAN ASTRONAUTICS LIMITED (CAL)

The accompanying Exhibits, C-16, C-17, and C-18, summarize CAL's business forecast for the period 1981-1990. This forecast was prepared on the basis of CAL's 1980 AIAC business enquiry as revised following discussions with CAL management.

The key assumptions and features contained in that forecast are as follows:

- 100% of CAL's sales are assumed to be space-related.
- As a general sales strategy, CAL expects to exploit its battery management system and SAR-SAT terminals in foreign markets. These two items are anticipated to account for sales of $5-20 million and $10-20 million, respectively, in the next five years.
- CAL based its sales forecast on the assumption that either RADAR-SAT or M-SAT would go forward in addition to L-SAT. In effect, CAL expects Case 2 to prevail. Case 3 would therefore represent an increase in business, while Case 1 a decrease.
- For each of the major domestic programs, CAL expects to contribute battery management systems, testing, and mission control equipment and to participate in the initial system studies.
- Sales under RADAR-SAT would reach about $9 million and those under M-SAT about $5.5 million. DBS sales would be similar to those for M-SAT.
- For L-SAT, CAL expects to supply the power subsystem for $4.1 million.
- Other forecast sales include work under the NRC/NASA joint Space Science Program and work on synthetic aperture radar with MDA.
- As a general trend, government is expected to become a less important customer in the future, although it would still account for some 20% of total sales. It now accounts for about 30% of sales.

EXHIBIT C-19

CANADIAN ASTRONAUTICS LIMITED

FINANCIAL AND ECONOMIC RESULTS

| | Private Internal Rate of Return (%) | Social Net Present Value ($ million 1981) |
|---|---|---|
| Base Case | 69 | 29.7 |
| Base Case and RADAR-SAT | 76 | 33.7 |
| Base Case, RADAR-SAT and M-SAT | 79 | 39.7 |

- Exports are anticipated to stay at their current level, that is, about 55% of sales.

- In support of its sales efforts, CAL plans on devoting an average of 6% of its gross sales to its own R&D efforts. Its plans also call for substantial investment in plant and equipment to keep pace with its expanding sales.

- CAL's reliance on imports is considerable: about 55% of the direct matierals and 60% of equipment.

- Gross value added is estimated at about 55% of sales, with labour costs equivalent to about 30-35% of total sales.

- Little government assistance is assumed by CAL. However, it has received grants in the past and would expect to continue to use SSC's unsolicited proposal fund and may request DIPP capital assistance. Minimal amounts of such assistance were included in the forecast.

CAL does not see that it would not face a capacity constraint if three major programs were undertaken in the next three years.. Labour supply, nevertheless, is perceived as a problem especially for electronic circuit designers, space system designers, and experienced project managers. Roughly 20% of CAL's staff would be trained assembly workers, 20% administrative, and the balance professional engineers and computer scientists.

CAL perceive its chances of fulfilling its sales forecast as very good. To date, it has achieved a very high rate of successful tenders, won competitively.

As its principal marketing strategy, CAL sees using its growing reputation for high quality and dependability at a reasonable price. Its future success relies in part on the success of the SAR-SAT program and continued government support for R&D, government acceptance of first buyer risk, and international endorsement.

## IMPACT OF ALTERNATIVE GOVERNMENT EXPENDITURE LEVELS

Exhibit C-19, <u>opposite</u>, presents the private and social return calculations for CAL. A very high private return is expected for CAL, varying from 60% to 79%.

Its returns improve considerably under the high scenario. The estimated social return on CAL's operation amounts to \$29.7 million to \$39.7 million.

# APPENDIX D

## SENSITIVITY ANALYSIS

## EFFECT ON SOCIAL RETURN OF VARIATION OF ASSUMPTIONS

- Social Valuation of Foreign Exchange
- Social Opportunity Cost of Labour

NET PRESENT VALUE

ALTERNATIVE I: NO LABOUR BENEFITS

| | Base Case | Base Case Plus RADAR-SAT | Base Case Plus RADAR-SAT Plus M-SAT |
|---|---|---|---|
| Social Benefits | $266.9 | $326.1 | $439.1 |
| Social Costs | (91.6) | (127.9) | (158.4) |
| Net Social Benefit | 175.3 | 198.2 | 280.7 |
| Industry Adjustment | (127.9) | (127.9) | (127.9) |
| Industry Social Return | $ 47.4 | $ 70.3 | $152.8 |

## INTRODUCTION

In order to gain additional perspective on the social return on investment as calculated in the study, it may be helpful to present the same calculation under varying assumptions for certain of the key parameters that enter into the social return calculation. These are principally the following:

- the social valuation of foreign exchange
- the social opportunity cost of labour.

Additional sensitivity analysis could also be undertaken on the other variables and on the companies' private returns. That, however, is not being done as part of this presentation.

### Alternative I: Social Opportunity Opportunity Cost of Labour

The accompanying table presents the results of the social return calculation under the assumption that the social opportunity cost of labour is equivalent to the actual wage bill paid by the companies. That is to say, it is assumed that workers presently employed in the space industry would have no difficulty in finding alternative employment that pays equally well. No employee would require unemployment assistance and all employees would not encounter a break in employment: other jobs would be found immediately. As can be seen opposite, the effect of this change in assumption is to reduce the industry social return under each scenario. Further, the possibility of the industry's social benefits compensating for a premium on Canadian purchases is reduced: the addition of RADAR-SAT could sustain at most a premium of $22.9 million (1981$) or 18% and the addition of M-SAT could sustain at most $82.5 million (1981$) or 35%.

### Alternative II: Foreign Exchange Valuation

Under this alternative, the social value of foreign exchange is assumed to be 7% greater than its nominal value (instead of 15% greater as assumed in the study). This reduction could be justified on the basis that over the next decade trade barriers, notably tariffs, are expected to be lowered. The effects of this change are to reduce the industry's social return substantially, as can be seen below.

NET PRESENT VALUE

ALTERNATIVE II: REDUCED FOREIGN EXCHANGE PREMIUM

| | Base Case | Base Case Plus Base Case Plus RADAR-SAT | Base Case Plus RADAR-SAT Plus M-SAT |
|---|---|---|---|
| Social Benefits | $187.0 | $222.6 | $305.5 |
| Social Costs | 70.9 | 98.6 | 120.8 |
| Net Social Benefits | 116.1 | 124.0 | 184.7 |
| Industry Adjustments | (127.9) | (127.9) | (127.9) |
| Industry Social Return | $(11.8) | $ (3.9) | $ 56.8 |

The overall social return falls into a negative position under the first two cases but remains positive under the third case.

The extent to which government would be willing to pay a premium on RADAR-SAT and M-SAT is determined by the differences between the cases. Even though there is a net social cost, government could pay up to $7.9 million (1981$) or 6% to purchase RADAR-SAT domestically. It could further pay up to $60.7 million (1981$) or 25% to have both M-SAT and RADAR-SAT procured locally.

Alternative III:
Alternatives I and II Combined

The combined effect of changing both assumptions for the social values of foreign exchange and for labour are shown following. In this case, the industry's social return is negative in the first two cases and positive under the third case.

## NET PRESENT VALUE
## ALTERNATIVE III: REDUCED FOREIGN EXCHANGE PREMIUM
## AND NO LABOUR BENEFIT

| | Base Case | Base Case Plus RADAR-SAT ($'Million 1981) | Base Case Plus RADAR-SAT Plus M-Sat |
|---|---|---|---|
| Social Benefits | $162.9 | $196.8 | $282.6 |
| Social Costs | (70.9) | (98.6) | (120.8) |
| Net Social Benefit | 92.0 | 98.2 | 161.8 |
| Industry Adjustments | (127.9) | (127.9) | (127.9) |
| Industry Social Return | $(35.9) | $(29.7) | $33.9 |

The difference between cases indicate that government may nevertheless still be willing to pay a premium on procuring from Canadian sources in order to reduce its social costs. In the case of RADAR-SAT, it would be willing to pay a premium of up to $6.2 million (1981$) and in the case of two major satellite programs together up to $67.8 million. These amounts are equivalent to a purchase price of 5% on RADAR-SAT and 28% on M-SAT (or DBS) and RADAR-SAT respectively.

THE IMPACT OF CANADA'S SPACE PROGRAM
ON THE SPACE INDUSTRY