A SPACE POLICY FOR CANADA

- AN INDUSTRIAL VIEWPOINT -

Presented by

THE AIR INDUSTRIES ASSOCIATION OF CANADA

Endorsed by

THE ELECTRONIC INDUSTRIES ASSOCIATION OF CANADA

February 1974

FOREWORD

At its October 20th, 1972 meeting, the Business Opportunities and Planning Committee of the Air Industries Association of Canada (AIAC) resolved that a Subcommittee be formed to develop a cooperative approach to the space systems activities of member companies.

The Subcommittee was formed on November 21, 1972 with the election of the following officers:

Mr. John MacNaughton - Spar Aerospace Products Ltd. - Chairman
Mr. Donald McLean - RCA Limited - Vice-Chairman
Mr. Keith Burrows - Bristol Aerospace Ltd. - Secretary

and the development of the following terms of reference and definitions:

TERMS OF REFERENCE

1. To provide an Industry focal point for the discussion and subsequent formulation of appropriate Space Policy for Canada as it may affect Canadian Industry.

2. To assist Government in the formulation of a coordinated space plan for Canada as it can best relate to the Canadian space industry.

3. To encourage the development of a "World Class" Canadian Industry through funding provided by Government to Industry, both directly and via various Government user agencies.

4. To ensure that Canadian Industry participates to the fullest extent practicable in future Canadian space projects. Such involvement to maximize the potential for export sales to the World at large.

DEFINITION OF SPACE

The scope of the Subcommittee's activities embrace those industries involved in the following areas:

- Satellites
- Boosters and Propulsion Systems
- Sounding Rockets
- Earth Terminals

After due consideration, a more detailed definition of Space Systems as related to the Subcommittee's activities was developed, as follows:

5/GGQ/2

SPACE SYSTEMS

Space Vehicles

(a) The Satellite Bus. This includes structure, on-board propulsion, attitude control, temperature control, power generation, conditioning and distribution, telemetry and command; and in fact, everything which is required to carry the "passengers" or payload (which could be communications or sensory) in comfort.

(b) The Payload. This includes all equipments carried in the satellite bus necessary for the conduct of the satellite's mission. If it is communications, it would include antennas, transponders, TWT's, waveguides, etc.; if it is earth observation, it would include the sensors; and if it is scientific, it would include the scientific instruments.

(c) Sounding Rockets. This includes the rocket vehicle and its payload, as they are generally physically inseparable during the course of a mission.

(d) Space Borne Servicing. This includes:

i) for unmanned satellites, the redundancy or other system(s) to return the vehicle to operational service after an in orbit malfunction.

ii) for manned satellites, the techniques used by astronauts to diagnose faults and effect repairs, e.g., remotely operated manipulative systems.

Launch and Post Launch Activities

(a) Launch Complex. This would include existing launch facilities located throughout the world. Particular attention would be paid to Canadian facilities - the existing one at Fort Churchill, its capabilities and its future use, and also the need or otherwise for upgraded or new facilities.

(b) Launch Vehicles. This would include existing launch vehicles available throughout the world, particularly the U.S. Scout, Thor Delta and Titan series, and the impact of the Space Shuttle. Particular attention will be paid to potential Canadian launch vehicles, their performance and uses; this in conjunction with recognition of the need or otherwise for a national effort in this field from a strategic policy point of view.

Ground Support Systems

(a) Tracking Telemetry and Command Stations. This includes all ground based operations associated with commanding a space vehicle after a successful launch, and would deal with position and attitude determination and control, system function and repair, etc.

(b) Earth Receiving and/or Transmitting Stations. This includes all ground installations associated with receiving mission data from the space vehicle and processing it to a condition suitable for onward distribution to the user. In the case of the space vehicle acting as a repeater, it includes the installations associated with transmitting the data to be repeated from the ground to the satellite.

(c) Ground Support Equipment. This includes specially designed equipment to test, transport and service the space or launch vehicle during its construction and preparation for launch at the launch complex.

The Subcommittee's activities were augmented in mid 1973 by the addition of an official representative of the Electronic Industries Association of Canada (EIAC).

The Subcommittee has met twelve times since its formation and the following report represents the results of its deliberations to date. During the preparation of this report, views have been exchanged with Government departments and committees, academic institutions and Telesat Canada Ltd.

Subcommittee members have prepared material and participated in discussions leading to the preparation of this report. The contributions of the following members and their respective companies are appreciated and hereby acknowledged.

Bristol Aerospace Limited
Mr. R.J. Bevis
Kr. K.F. Burrows

Canadair Limited
Mr. S. Bernstein
Mr. J.R. Henry
Mr. J. Kerr
Mr. R. Nishizaki

Dilworth Secord, Meagher and Associates Limited
Mr. L.C. Secord
Mr. J.H. White

Fleet Industries, a Division of Ronyx Corporation Limited
Mr. G. Sampson

Northern Electric Company Limited
Mr. W.H. Barrie (EIAC Representative)

RCA Limited
Mr. J. Collins
Mr. D.D. McLean
Mr. J.M. Stewart

Spar Aerospace Products Limited
Mr. J.D. MacNaughton
Mr. A.G. Red

United Aircraft of Canada Limited
Mr. H. Bruce
Mr. J. Chisholm

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 The Need

The satellite and its supporting ground based installations is now coming to maturity as a vital element in many of the complex systems being demanded by the peoples of both advanced and developing nations.

The use of satellites as an important tool in communications and weather forecasting systems is already a matter of record.

The effect that these satellite systems have had on increasing real productivity by both increasing output and reducing the loss of resources is substantial.

It is simply a matter of time before satellite systems are in everyday use for additional tasks demanded by society such as:

Resource Discovery and Management
Traffic Control
Navigation
Environment Monitoring and Control

1.2 The Opportunity

Canada is almost unique among nations with its vast land mass and Northern location, together with its small population, generally concentrated in a handful of Southern cities. Canada's untapped renewable and non-renewable resources in her Northland and off her shores, together with her highly advanced technological population and supporting industrial infrastructure in fields related to these unique properties, present both challenges and answers for future development.

These unique properties make Canada a natural spawning ground for the development of advanced satellite systems required firstly to serve the needs of our country as it continues its growth and secondly to exploit the export markets which such developments create. Canadian Industry can play a vital role in seizing this opportunity and capitalizing on it.

1.3 The Problem

There would seem to be little doubt that Canada is potentially a large purchaser and user of space systems.

5/GGQ/7

However, although the third country in the world to build and operate an earth orbiting satellite (the highly successful Alouette I launched in 1962), Canada has no planned space activity. It has completed a series of discrete space projects at approximately 2½ year intervals, with little or no overall planning.

There is little doubt that the future users and/or purchasers of such systems are likely to be Government departments or agencies in which Government has substantial interest and/or control.

The objectives and programs of these departments and agencies almost inexorably result in their becoming purchasers and users of space systems in order to accomplish their missions. To name a few such users and some of their interests, we have:

Department of Communications	- Communications Research - Overseas Telecommunications - Regulation of International Communications
Telesat Canada Ltd.	- Domestic Communications by Satellite
Department of Energy Mines & Resources	- Resource Discovery Inventory & Control - Earth Sciences Survey - Canada Centre for Remote Sensing program
Department of the Environment	- Marine Sciences Survey - Environment Monitoring - Pollution Detection and Control
Ministry of Transport	- International Air Traffic Control - Domestic Air Traffic Control - Maritime Navigation
Department of National Defense	- Communications - Observation - Contribution to collective defense - Defense Research program
National Research Council	- Space Research Facilities Branch program

5/GGQ/8

These agencies need space systems to accomplish their missions.

Other departments such as Industry Trade & Commerce, Science and Technology, Regional and Economic Expansion, and External Affairs, while not users, also have a distinct interest in space systems as they affect national development.

Thus space interests at the Federal level are widely diffused among at least one dozen departments and agencies. An Interdepartmental Committee on Space has been in existence for some years to coordinate the requirements of these groups. However, this committee has no direct authority or funding ability, and thus has provided a forum for the exchange of ideas rather than a forum for decision.

Individual Departments have difficulty in justifying space expenditures per se since primarily they are not concerned with space, using space only as a means to the end of satisfying their particular departmental mission. With the exception of the Space Research Facilities Branch of the National Research Council, the only Federal Department which clearly embraces space is the Department of Communications, probably since space communications has clearly established its usefulness. And yet space systems and their related technologies are interwoven into many of the programs of the others.

The result is a fragmentation of the space related interests and activities of the Federal Government, creating in turn a most difficult problem for the domestic Industry serving these interests. The basic problem lies in the fact that since there is no overall space activity planned at the Government level, the Industry cannot anticipate the future requirements of the user, and thus is often unprepared to meet his needs.

This in turn results in the fact that the necessary basic technological development work on components and subsystems for future Canadian satellite systems does not take place either in Government or Industry, other than on a crash basis after a complete satellite system project has been initiated.

1.4 An Approach to the Solution

Since the user/operator of space systems is generally Government or closely related to Government, the market is conditioned by Government initiative rather than by private enterprise. This being so, the Federal Government should recognize that space systems are a vital element in the development of Canada, that an effective Government/Industry infrastructure is an essential ingredient in the definition, procurement, construction and operation of such systems, and that the fundamental initiatives in this regard must derive from Government policy.

A central Federal agency concerned with such systems could develop a program which would concentrate on "Canadian Unique" problems such as communications, resource management, and Arctic survey and navigation.

It will follow that the Industrial centres of excellence developed within Canada in the execution of such a program will find export markets either as individual companies or as consortia, selling complete systems or parts of systems to countries or groups of countries with requirements for similar systems, but with a technology and industrial base less well developed than Canada's. Such countries might include:

Australia
Brazil
India
Indonesia
Malaysia
Africa

It is hoped that this report, in elaborating on these matters, will be helpful in suggesting how Government and Industry can best combine their resources to satisfy requirements for domestic space systems and develop therefrom substantial export sales.

2.0 HISTORICAL

In dealing with the problem of the development of Space Policy for Canada, many Government initiatives have taken place over the last decade. The following lists some of the key milestones.

2.1 The Development of Policy

The report "Upper Atmosphere and Space Programs in Canada" was commissioned in May, 1966 by the Science Secretariat and was published in February, 1967. It recommended a space program for Canada aimed at solving telecommunications and survey problems in Canada.[1]

A report entitled "A Space Program for Canada", was issued by the Science Council in July, 1967. It found that a coordinated, expanded, and sustained national endeavour would be required if Canadian use of space is to be developed under Canadian leadership, to meet the needs of the Canadian economy. It recommended the formation of a Central Agency to deal with space related matters in Canada.[2]

A White Paper by the Honourable C.M. Drury entitled "A Domestic Satellite Communications System for Canada" was issued in March, 1968. This document developed the case for a domestic communications satellite system and a satellite communications corporation to be owned by both Government and the private sector.[3]

A report entitled "Towards a National Science Policy for Canada", was issued by the Science Council in October of 1968. The Council noted that "the application of science and technology will make significant contributions to the solution of economic and social problems in Canada and in so doing will contribute to the realization of the goals of the nation".[4] To implement these recommendations, the Council identified two major prototype programs, one of which was to cover Canada's interest in space.

This was followed by "Bill C-184" - better known as "The Telesat Act" which was passed by the House of Commons June 13, 1969. This act set up a company to establish satellite communications systems on a commercial basis in Canada. It stated that Canadian research, design and industrial personnel, technology and facilities be utilized to the extent practical and consistent with the commercial nature of the company in the design and construction of its systems.[5]

Thus, the development of space policy in Canada moved gradually from recommendations on a broad front to very specific actions related to operational communications systems.

In the meantime, the Senate in November 1967 set up a special committee under the Chairmanship of the Honourable Maurice Lamontagne to review science policy in Canada. The Lamontagne reports dealing with this matter have been published in three volumes between 1970 and the present.[6]

Also, on May 25, 1971, the AIAC, jointly with the EIAC, submitted a brief to the Prime Minister entitled "Canadian Government Spending and the Make or Buy Problem in the Context of National Industrial Strategy". This was followed by AIAC briefings of Cabinet Ministers and Officials.

The result of these and other actions pointed out, among many other facets of science activity management, the dramatic positive effect on the economy of industrialized nations which results from contracting out R & D to domestic industry as opposed to conducting it intramurally within government. These effects are now quantifiable in terms of economic multipliers. This principle was recognized and the Government acted to change its make or buy policy accordingly.

2.2 Review of Early Programs (Up to 1967)[1]

In the meantime, Canadian Industry, largely on its own initiative, was already heavily involved in a variety of space projects, both at home and abroad.

RCA Limited was involved in many space projects covering both the space segment and earth terminals. In the space segment it produced the communications system for the pioneering Relay satellite in 1962 and subsystems for Alouette 1, Explorer XX and Pegasus programs, and assumed prime contractor role for the Alouette II and ISIS I and II, with Spar as associate contractor; and in earth terminals it produced the two stations at Mill Village, N.S., for Canada's external communications for the Atlantic community of nations and subsystems for early stations of other countries. A significant achievement in this period was the continued development of STEM products at Spar, as over one hundred satellites had carried STEMs by 1966. The work at Bristol centered on the design, development and manufacture of Black Brant sounding rockets. A study of the application of satellite communications techniques as a means of providing for Canadian requirements in the Arctic was undertaken by Bell Telephone Company of Canada. Northern Electric was primarily engaged in the development and manufacture of ground terminal equipment.

5/GGQ/12

In addition to these major activities, others were carried on by various organizations and companies. For example, the Telephone Association of Canada conducted a study of satellites as they related to telephones. Computing Devices of Canada was developing a micrometeorite simulation device and studied turbulent wakes created by high-velocity projectiles. A study of orbit injection control systems suitable for use with HARP vehicles was carried out by Aviation Electric. Canadair played a major role in the development of the Velvet Glove and Sparrow II missiles and applied the technology and experience gained in these programs to the design and development of a sophisticated reconnaissance drone system. Canadair also carried out studies for the USAF on crew escape system concepts for application to orbital vehicles. Other space oriented design and development programs undertaken by Canadair include the Black Brant II (for CARDE) and a large satellite tracking antenna erected at Shirley Bay.

2.3 Review of Later Programs (Up to 1973)[7]

Today, Canadian industry, together with several universities and government agencies, is still heavily involved in space and upper atmosphere projects.

Bristol now has seven different models of the Black Brant rocket vehicles which are being used to support domestic and export research programs.

Northern Electric provided a microwave repeater and an additional 72 Travelling Wave Tube amplifiers for the Intelsat IV satellite series. In addition, they provided the electronics for the three Telesat Anik satellites.

Bell Northern Research Laboratories undertook systems studies involving the integration of satellite facilities into the Canadian telecommunications network, as well as being involved in the project definition phase of the Communications Technology Satellite (CTS) project.

RCA was involved in the construction of 18 earth stations, ten of which were for Canada's domestic system, the others being Intelsat type stations in the international market. The company produced earth station subsystems for 47 other stations. RCA participated in the systems planning and program definition stage of the CTS program; RCA has the responsibility for the design and development of the antennas, transponder, TT&C, (Tracking, Telemetry and Command) and power conditioning subsystems of this satellite.

5/GGJ/1

A 2 year company development program on transponders, graphite fibre epoxy composite filters, and antennas led to a 1973 award for supply of complete communications system for a 24-channel U.S. domestic satellite.

Work at Spar was devoted to the Anik satellite as subcontractor to Hughes Aircraft and currently is concerned with design and manufacture of the power generation, structure/thermal and attitude control subsystems of CTS and other advanced communications satellites such as that which Lockheed plans to offer to Intelsat and U.S. Domestic Communications Satellite system users. Spar is also working on rotary power transfer devices and flexible solar array actuators for a new generation of application satellites as well as continuing development on various STEM applications.

Canadair has concentrated in recent years on the development of advanced technology in the applied mechanics and materials and process fields. Extensive development work has been conducted on producing sophisticated static and dynamic structural analysis methods and on solving the engineering and fabrication problems in applying advanced materials such as boron-aluminum, boron-epoxy and graphite-epoxy to the Space Shuttle and auxiliary projected systems.

SED Systems Limited designed and built several rocket payloads and conducted studies in the field of attitude acquisition and instrumentation.

It is a matter of record that Canadian sponsored projects to date have created a capability in Canadian Industry to address export markets.

Out of Alouette/ISIS grew the STEM product line and low noise telemetry and command receivers and transmitters.

Out of the Anik (Telesat) program grew a new trading relationship with respect to the space sector, resulting in offset agreements whereby satellite structure and electronics were built in Canada to U.S. designs and were augmented by long term production contracts between the Canadian vendors and the American prime contractor. The ground sector was Canadian designed and manufactured. The overall system itself was designed and put into operation by a Canadian carrier, Telesat Canada Ltd. - a significant achievement.

5/GGJ/2

The CTS program is not yet complete; however significant technological advances and international relationships are already developing at the industrial level. These are typified by:

- lightweight high performance transponders
- efficient, cost effective attitude control systems
- advanced deployable solar arrays
- advanced lightweight structures
- trading relations with ESRO countries.

The Black Brant sounding rocket, initially sponsored by the Defense Research Board and latterly by the National Research Council has developed into a viable export item.

It is also a matter of record that these export results have come from an ad hoc approach to industrial space activities in Canada as opposed to a planned approach integrated with Government requirements. Planning could only improve such performance.

2.4 Summary

Thus, despite the lack of a planned space activity, Canadian industry has participated successfully in the Black Brant, Alouette and ISIS projects. The Canadian domestic communications satellite project, Anik, and the initial phases of the CTS project, have also benefited Canadian industry in terms of employment and ensuring continuance of a capability in the field which is at least contemporary with that of other countries and in many aspects, is ahead.

The Canadian Space Industry, composed of four companies with a major involvement and some fifteen companies with more than a passing interest, have, over the last fifteen years, recorded sales of some $150 million resulting in an average employment of approximately 700.

5/GGJ/3

3.0 ELEMENTS OF A VIABLE INDUSTRIAL SPACE POLICY

3.1 National Priorities

Faced with limited resources and many demands for the application of advanced technology, the question has been asked: "Does Canada need a space industry?" It has been argued that Canadian interests could be adequately served through the acquisition of its space hardware and services from other nations who have already made space systems development a matter of national policy.

This thesis ignores a number of facts, including the following:

- Canada has the second largest land mass in the world. The northerly geographical location of this land mass is only paralleled by that of Russia.

- The bulk of Canada's land mass is in northerly climes, rich in natural resources where sparse population groupings, rugged terrain and inclement weather inhibit effective terrestrial communications systems for social and economic development.

- Canada's standard of living and technical sophistication are amongst the highest in the world.

- Canada's output of scientists and technologists, per capita, is amongst the highest in the world.

- To preserve sovereignty over its extensive resources and large land mass with its limited and widely dispersed population, Canada must ensure that it has assured access to reliable and economic communications and earth observation capabilities throughout its territories.

These facts, when considered in the aggregate, provide a persuasive argument for maintaining the expertise within Canada to serve its special interests in space. This would simply be a continuation and broadening of existing policy, where, for example, it has been traditional for Canada to control its terrestrial communications systems by the granting of monopolies which include domestic design and manufacturing capabilities.

Canada is vastly different from most countries. Its citizens have different needs with respect to communications and earth observation systems than citizens of other countries.

5/GGJ/4

It should not be tacitly assumed that it will always be possible to procure such systems from foreign sources in the future. The seller may not wish to sell either his most advanced product, or an inferior version. Indeed he may be restrained from prosecuting such sales.

To assume control of and continued access to such systems implies Canadian ownership of the system, Canadian operation of the system and Canadian maintenance of the system.

In that these systems must be designed with Canadian requirements in mind, Canadian design and manufacture of the system and many of its component parts is implied, which in turn ensures the supply of parts and expertise necessary for system operation and maintenance.

Subsidiary benefits from supporting a Canadian space industry would follow in the creation of jobs, expertise, national pride and prestige, and the ability to assist less favoured nations in the fulfillment of their related objectives in space and its associated technology.

In the establishment of national priorities for science and technology, a reasonable level of funding provided in support of a well planned space activity will cover a broad spectrum since its application calls upon the skills of a wider cross-section of scientific and technical disciplines than are found in most other advanced technology fields. In addition, the nucleus of such an activity and its principal industrial components already exists, requiring only formal confirmation of the Government's intent to maintain its prior practices, while initiating additional effort in Industry towards the technological development of subsystems, components and systems analysis to meet Canada's future space systems needs.

In that the CTS program is now approaching its climax with no approved follow-on space systems project in sight, if the existing Industrial capability is not to be disbanded, a decision with respect to the continuation of space activities within Industry in Canada must be made in the very near future.

In the light of Lamontagne[6] and others in recent years, it is perhaps superfluous to comment on why such work should be undertaken within industry rather than within Government establishments. Suffice it to say that the Canadian space industry has already demonstrated its ability to market its capabilities internationally, despite the tenuous domestic procurement policy which has developed over the past fifteen years.

5/GGJ/5

3.2 A Possible Scenario

Like other countries which do not have military space programs, Canada is required to justify funds for space, largely on a civilian basis. Until recently, space projects have involved the interests of scientists and their sophisticated investigations, with little apparent connection with basic day-to-day issues affecting the citizen. Now the trend is towards the practical application of what has been learned about space in the last fifteen years. This should allow easier justification of a planned space activity in terms of its satisfaction of the requirements and demands of the citizen. Such applications as improved communications, better weather forecasting and resources management are tangible benefits and thus more acceptable to the tax payer. On this basis, Canada should be ready to assume a more definitive role in the world space community. The question is to what extent. The answer must lie in agreed opinion and direction from Government and an informed and responsive Industry.

A step toward a unified space policy as it relates to Industry is to establish an acceptable and logical agreement as to what Canadian Industry can and should undertake. In reaching such agreement, the traditional economic character of Canada may emerge with Canada being regarded as a nation of raw material and subcontract suppliers. Do we wish to have a space policy reflecting this attitude -- one which is dependent on the space programs of other countries - one which involves Canadians mainly as subcontractors to U.S. prime contractors -- one which requires Canada to depend on U.S. launch vehicles? Such a policy would be easy to establish and might be considered adequate. It would involve only minimal coordination within Industry and require only limited guidance from Government.

On the other hand, perhaps Canada should be undertaking a more national, more independent posture. The maintenance of the security of, and ensuring continued access to, our communications and earth observation systems would mitigate in favour of such a stance. This country has the basic resources -- trained manpower and facilities. Perhaps it may only be a question of developing a national confidence. If Industry were to agree that greater independence from foreign sources is practical, and assuming that such a position is attractive to the Government, it would be possible to plan a program which would involve all the basic elements of space applications technology. i.e., ground stations, rocket boosters, satellite structures, space electronics, sensors and probes. These elements exist in Canada today, to some degree or other. Some would require more development than others to become technologically viable. Looking at each in turn:

1. Ground Stations and Networks

Canada already has a vast national communications microwave and hard line network which is being supplemented by the Anik communications satellite system. Provincial telephone companies and established communications industries exist across the nation, each of which is committed and prepared to support the establishment of satellite ground based stations.

2. Rocket Boosters

It is recognized by the Canadian Government that Canada has a major national asset in a propellant plant capable of manufacturing rocket motors up to diameters of 30 inches, let alone larger diameters available with future expansion. The National Research Council has confirmed the feasibility of clustering Canadian-made rocket motors to launch satellites. Also the possibility of manufacturing proven rocket motors under license should not be discounted. The government departments of the NRC and the Defence Research Board have manpower and facilities to support such an undertaking. A rocket launch range undeniably exists at Fort Churchill.

3. Satellite Structures and Materials

Canada has already proven its ability to design and manufacture satellite structures. It has gained international recognition for building some of the best satellites ever launched by any nation. Technology and design and test facilities exist within Canadian industry and universities as well as Government agencies.

4. Space Electronics and Testing Facilities

Canadian industry here too has extensively committed itself to the development, design and manufacture of space electronics. The success of this commitment has been demonstrated by the launches of the Alouette/ISIS series and now the Anik satellites. The fact that these satellites continue to operate reliably reflects the high standard of Canadian design and manufacture.

5. Sensors and Probes

Sensors and experimental programs are apparent in Government agencies and universities as well as in Industry. This area, as with Rocket Boosters, also needs further development. At the present, the effort seems uncoordinated and individualistic. Coordinated, the resulting products could represent a significant export potential and abundant technological spin-off.

6. The Overall System

System Engineering and Program Management skills exist in a fragmented fashion lying amongst various Government Laboratories, Telesat Canada and Canadian Industry.

3.3 A Possible Plan

If Canada were to consider a coordinated space activity, including these elements in a balanced fashion, it would not only be Canadian, but also it would tend to sustain and increase the present industrial subcontract export business with U.S. primes and develop export potential of Canadian proprietary items. Such a space activity could contain the following features:

Domestic

1. Develop a world wide reputation as experts in the fields of communications, resources management, and arctic surveillance as they pertain to unique Canadian requirements and the maintenance of Canadian control over the resulting systems.

2. Develop probes, sensors and detection equipment for use on small satellites injected into polar orbit by Canadian-built boosters.

3. Refine existing ground based receiving and command equipment to complement the undertakings suggested in (2) above.

4. Design and manufacture within Canadian industry an increasingly large proportion of the space-borne portion of the systems.

5. Contract for the launch of large satellites with NASA, using conventional boosters or the Space Shuttle system when it becomes operational in the 1980's.

Internationally

1. Develop export markets for Canadian proprietary items such as sensors, probes, materials, structures, transponders, antennas, power systems and telemetry and command.

2. Offer small satellites and boosting capability for export. The primary market would be countries with similar space interests as Canada's.

3. Develop export markets for earth terminal equipment, and in particular small inexpensive stations for use in remotely located communities in conjunction with direct radio program reception and low capacity telephony service.

4. Participate in the Committee on Space Research (COSPAR), the United Nations Committees on the peaceful uses of outer space and other international committees dealing with space matters.

5. Establish bilateral space agreements with countries interested in participating in Canada's space projects and vice-versa.

6. Offer derivatives of Canadian satellites and satellite subsystems - developed to satisfy Canadian needs - for export.

This particular scenario illustrates a balanced national space endeavour which would increase existing Canadian design and manufacturing capability while contributing to the world-wide space effort and at the same time satisfying domestic needs.

To date, Canadian Government policy has resulted in the design, manufacture and deployment of six satellites over a 15 year period, with a seventh and eighth satellite (CTS and ANIK III) scheduled to be launched in 1975. This is an average of one Canadian satellite launched approximately every 2½ years. There have, however, been only four generically different projects in this time frame - Alouette, ISIS, Anik and CTS.

If it were not for the deep-rooted belief of a very few Canadians in the practicality of space technology, this level of activity would have been inadequate to maintain a continued Canadian industrial position in the field. The gaps between projects, without other supporting work, would have proved too great to maintain industrial teams in being on a viable basis. The effort to date has, however, had one significant merit (in which it may be compared favourably to a number of national programs in Europe). It has provided flight experience for Canadian equipments leading to the export sales by Canadian Industry of similar components and subsystems. It does appear, however, that there are lessons to be learned from the Europeans and Japanese, in that they, like the U.S., have initiated and maintained long term programs for the design and development of advanced subsystems and components together with the supporting technology which maintains the specialist teams between new satellite project starts and provides the basis for developing new satellite systems.

For a Canadian domestic space systems endeavour to be effective, it must:

a) continue the present practice of launching a new domestically designed and manufactured satellite system at least every 2½ years, and preferably once every 2 years. This schedule provides just enough project overlap to keep the highly qualified industrial project teams in being, and

b) initiate a program, contracted out to Industry, for subsystem and component development and basic technology in selected areas of required high competence in anticipation of future Canadian space systems requirements. This area of support technology is the critical missing element in Canada's space activities to date as compared with the position within the United States, Europe and Japan.

The work load for the two activities i.e., developing complete satellite systems and support technology, can be balanced so that the critical mass of key personnel and facilities within Industry remains continuously at work and thus is competent to undertake future Canadian projects as well as to maintain and increase penetration of export markets.

Based on our observations of space activities in other countries, expenditures on basic technology run between 5% and 10% of the total budget, the remainder being allocated to specific projects.

5% seems appropriate for countries or groups of countries with large space activities such as the United States and the European Space Agency, while 10% seems appropriate for countries with a smaller total effort.

5/GGJ/10

Assuming a Federal Government annual expenditure rate on space activities of some $30 million,[9] $3 million devoted to technology would result from following the above line of reasoning. It also agrees closely with the expenditures which we believe must be spent annually by Government in Industry to develop technology which will be needed for future domestic projects.

It cannot be reiterated strongly enough that these expenditures are not of a make work nature. In a properly conceived space activity, they relate to Industrial activities associated with the configuration of new Canadian space systems, plus the reduction to laboratory hardware of critical subsystems and components within those configurations, so that the technology base is secure when a new project is initiated. This work must be done in anticipation of the requirements of such a new project.

Space systems endeavours, in view of their relatively high cost and the fact that satellites overfly many countries, generally result in international involvements. These involvements cover a spectrum from regulatory arrangements to participation in the projects themselves.

Canada, because of its undoubted interest in space systems and the relatively small scale of her resources allocable to advanced technology, should seriously consider expanding international ties in space, which to date have been mainly associated with regulatory and launcher matters.

Under the umbrella of Science and Technology agreements or similar arrangements, Canada should actively seek partners in cooperative bilateral or multi-lateral science and technology space systems programs. In this fashion, as well as maintaining an essential domestic interest in international affairs, Canada and the domestic industry can participate in the wide range of benefits which will accrue from the conduct of joint projects with such countries or groups of countries as:

- The United States
- The European Space Agency
- Germany
- Belgium
- France
- Japan

3.4 Implementation

A major deterrent to the implementation of this or any coordinated plan is the fact that at present there is no one Government agency charged with the supervision of space programs in Canada, even though many Government departments intend to use space as an integral part of the advanced systems they are developing to accomplish their respective missions. It was the recommendation of the Science Secretariat in its Special Study No. 1 (which was subsequently endorsed by the Science Council in its Report No. 1) that a central agency be established within Canada to manage space activities. To date these recommendations have not been adopted by the Government. It is felt that these recommendations should be re-evaluated by Government. The passage of time has, if anything, strengthened the arguments for adopting a course of action along the lines of those recommendations.

Thus each Government Department that has an interest in space activities has developed its policies and programs independently except for the review of a coordinating body, the Inter-departmental Committee on Space, and the normal policing activities of the Treasury Board. The result has been the failure within the Government to assume the firm leadership posture required to provide the support and encouragement to Industry to allow it to satisfy the future needs of Government Departments and Agencies in terms of space systems.

Unless the Canadian Government, in addition to adopting a long term policy with respect to space technology within Industry, is prepared to adopt the Science Secretariat and Science Council recommendation of designating one Agency to assume executive responsibility for Canada's space activities and provide it with a budget to discharge this responsibility, it is probable that Canadian Industry will be unable to maintain its present competitive position in its specialist areas vis-a-vis the much more aggressive and coordinated efforts carried on within the United States, Europe and Japan. This will impair Canadian Industry's ability to satisfy future domestic requirements as well as capitalizing on export market opportunities.

In addition to the above recommendation with respect to the selection of a single Government Agency to coordinate space programs within Canada, it will be necessary for the Canadian Government, in negotiating its bilateral trade, its scientific exchange and its multi-national program agreements, to ensure that a more pragmatic and specific role is established for the participation of Canadian Industry pursuant to such agreements. There must be close Government/Industry cooperation prior to the execution of such agreements to ensure that the proper opportunities for Canadian

Industry are clearly identified. Such cooperation is vital if the full benefits of participation in multi-national space programs are to be enjoyed by Canadian Industry, in that Industry/Government long range plans must be harmonized.

5/GAY/2

4.0 THE MARKET

4.1 Introduction

The preceding chapter dealt with policies, philosophies and possibilities. No plan related to industrial policy can be conceived or implemented without a pragmatic look at markets to ascertain the commercial feasibility of the endeavour.

Over the next 25 - 30 years, there are certain to be a large number of customers for space systems such as:

- National Governments
- Groups of National Governments
- Oil or similar resource based companies
- Multi-national corporations with far flung holdings.

Not least among the countries which are likely to purchase such systems is Canada. This possibility is of prime interest to the Canadian space industry, as any sound business endeavour must be built upon an adequate domestic base.

The following sections derive a preliminary market model which can be used in forecasting where Canadian Industry's interests may lie both domestically and on the export market.

4.2 Customer Classification and Distribution

There would appear to be three basic kinds of customer:

(a) Communications
(b) Earth Observation
(c) Scientific

These three can be further subdivided into civilian and military users.

4.3 Market Size and Availability

4.3.1 On a gross scale, current annual space systems expenditures [8, 9] are in the order of:

U.S.A. (NASA)	$3,000 Million
(DOD)	$2,000 Million
ESRO	$ 100 Million
ELDO	$ 50 Million
Japan	$ 100 Million
European National Programs	$ 350 Million
Canada	$ 30 Million
Others (Brazil, India, etc.)	$ 150 Million
Intelsat	$ 20 Million
NATO, etc.	$ 20 Million
	$5,820 Million

5/GAY/3

4.3.2 It is unreasonable to assume that Canadian Industry has this large market available to it, as most of the developed countries have their own industries working in this field and are protected by "tariff" or "non-tariff" barriers.

However, it may be reasonable to assume that:

(a) The Canadian market is available to Canadian Industry for complete systems, subsystems and components.

(b) International and cooperative markets (where Canada has a financial interest) are available in relation to Canada's financial share.

(c) Other export markets are available to Canadian Industry on a subsystem or product basis, where Canadian technology and price is attractive on a competitive basis and/or imports from Canada are allowed on a preferential basis.

4.4 Market Analysis

In attempting to reduce the overall space systems market to sales volumes which could reasonably be expected to be realized by Canadian Industry, a number of assumptions have been made which could be optimistic or pessimistic. However, it is our general experience that market forecasts, when broken down into many elements, are likely to be reasonably accurate in gross while varying somewhat in detail.

To give this forecast substance, we have utilized the current nomenclature for certain potential projects. It is recognized that some of these projects will not materialize, but experience would indicate that others will take the place of those abandoned, or they may appear again under a different name or with an altered purpose. For conservatism, by no means all projected space projects have been included in this forecast, only those believed to be representative at this time.

4.4.1 The market has been segregated as follows:

(a) Current and potential Canadian space projects. These projects have been assumed to be represented by the following:

ANIK	- Almost finished.
CTS	- In being

5/GAY/4

VHF (Very High Frequency or multi purpose)	- Satellite for tactical communications in the North
Telesat II	- The replacement for ANIK I, II and III when they wear out.
BTV	- Broadcast satellite resulting from successful CTS experiments
CERES	- An Earth Resources satellite dedicated for "Canada Unique" requirements.
Domestic ATC	- The expansion of the International Aerosat program to domestic Air Traffic Control
Follow on Programs	- Assumed at one every two years.

(b) It has been assumed that the Canadian Sounding Rocket program will continue at a constant level of $1.5 million annually.

(c) Canadian contracted-out R & D in support of future Canadian projects.

This is R & D contracted out by Government to Industry to develop advanced subsystems, components and processes in anticipation of future Canadian space systems requirements with spin off into the export market. This is assumed to be constant at the $3 million per year level.

(d) The normal export sales of Canadian product lines or subsystems currently in being.

This market reflects the current export sales activities by the industry at the product level, and includes:

Black Brant sounding rockets
STEM systems
Telemetry & command systems
Ground stations
Offset requirements resulting from Telesat procurements
Transponder systems.

The size of this market has been assumed to remain constant at the current $9 million per year.

(e) Cooperative space programs - where Canada joins with another country to develop a space system of mutual interest.

This forecast assumes:

- participation in the Post Apollo development program, followed by guaranteed production follow on contracts from NASA.

- Participation with NASA on Earth Resources payloads and ground read out equipments, which might be reflected in NASA's EOS (Earth Orbiting Satellite) series.

- A cooperative development with a country such as Germany (under the umbrella of the science and technology agreement) for a project such as a Direct Broadcast Satellite. Other examples might be the Search and Rescue satellite project with the U.S., or the Maritime Orbital Test satellite project with ESA (ESRO).

- A new cooperative program every three years.

This forecast has assumed that Post Apollo participation rules stand, i.e. Canada pays for development and NASA guarantees follow on production. EOS participation would be completely Canadian funded in return for EOS direct read out. All other programs have been assumed to be shared 50/50 with Canadian Industry acquiring the Canadian share.

(f) International space programs - where Canada has a financial interest and a balance of payments requirement is established between the participants.

In this category we have assumed the following projects:

Aerosat	Where Canada is proposing to be a member of an international group to develop and test a preoperational air traffic control satellite.
Maresat	A similar preoperational program for maritime navigation.
Intelsat IVA	In progress.
Intelsat V	A possible RFQ in mid 1974.
NATO IV	Replacement for NATO III communications satellite.

5/GAY/6

Follow on programs at the rate of one new start every two years have been assumed. It has further been assumed that Canadian Industry could penetrate these projects to a level of 5%, based on the level of Canadian financial interest.

(g) Potential export market related to the sale of turnkey communications or earth observation satellite systems on the export market.

As mentioned previously, Canada, because of its unique requirements with respect to communications and earth observation systems, should be in a position to lead the world in the development and implementation of such systems. If Canadian Industry is involved in the design and manufacture of such systems, a substantial export market for similar systems becomes available.

This forecast is based on estimates of export domestic communication satellite programs only and assumes two basic models for Canadian Industrial penetration, namely 10% and 100%.

This market is shown as illustrative only, as its deep penetration will be difficult without a very real combining of Government/Telesat/Industrial leverages.

It also assumes that in the time frame considered there will be two basic classes of satellite - the Thor Delta booster class and a next generation of high power satellites requiring perhaps a Centaur or Titan launch.

4.4.2 For ease of computation, each technology or preoperational space systems program has been assumed to cost $50 million in contracted work with Industry, including the ground segment, and that a typical program lasts for 5 years from conceptual studies to post launch support and follows a distribution of expenditure rate skewed to the right. This skewing is due to the tendency for such projects to be preceded by extensive studies and analyses before major amounts of money are allocated.

Present generation operational or revenue producing projects are assumed to cost $30 million, including the ground segment, and last 3 years with a cost distribution skewed slightly to the left. This skewing is due to the fact that the customer tends to buy "off the shelf hardware" with heavy expenditures in Industry at the start of the project.

It is further assumed that a "second generation" satellite will be required in the late 1970's. This will be of higher power, higher accuracy and higher capacity than present systems. It will cost some $75 million including the ground segment, with the project lasting three years, with the expenditure rate again skewed to the left.

4.4.3 Based on the above reasoning, the share of the market available to Canadian Industry has been computed as follows:

Canadian Programs (4.4.1(a), (b) and (c))	100%
Normal Export Projects	100%
Cooperative Programs (except as noted in the text)	50%
International Programs	5%
Export Systems - Variable	10% to 100%

The results of this analysis are shown in Figures 1, 2, 3, 4, 5, 6, 7, 8 and 9 for the years 1973 to 1990.

Note: The market share is estimated at the "prime" contract level. The participation of lower tier Canadian Industry in these projects is implicit in the calculations which appear later in this report vis-a-vis employment levels, which assumes the same proportion of domestic to foreign procurement as currently exists. A planned space activity as proposed herein would increase the Canadian value added in the projects, and thus increase the overall economic impact of the endeavour.

4.5 Conclusions

On the basis of this analysis, there is a domestic market in excess of $20 Million annually.

There is an export market (export, cooperative and international) of a minimum of $9 Million annually and a maximum of over $100 Million annually. The penetration of that latter market being largely dependent on the entrepreneurial skills of Industry and Government jointly and severally.

The market size and distribution can form a viable business for Canadian Industry, but is dependent on the existence of the domestic base.

5/GAY/8

SPACE MARKET

AVAILABLE TO CANADIAN INDUSTRY

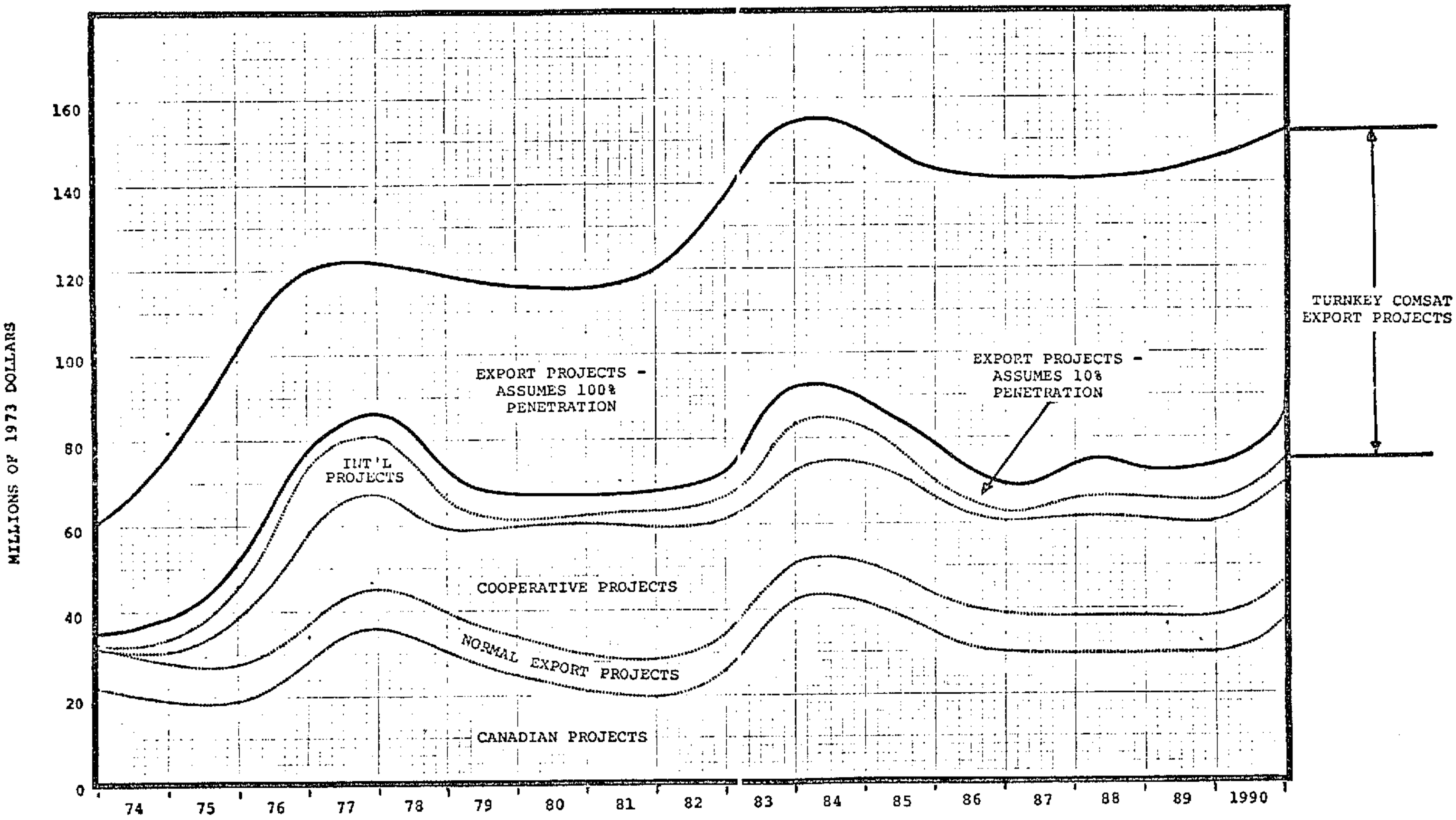

FIGURE 1

CUMULATIVE SPACE MARKET 1973-1990

AVAILABLE TO CANADIAN INDUSTRY

Millions of 1973 Dollars

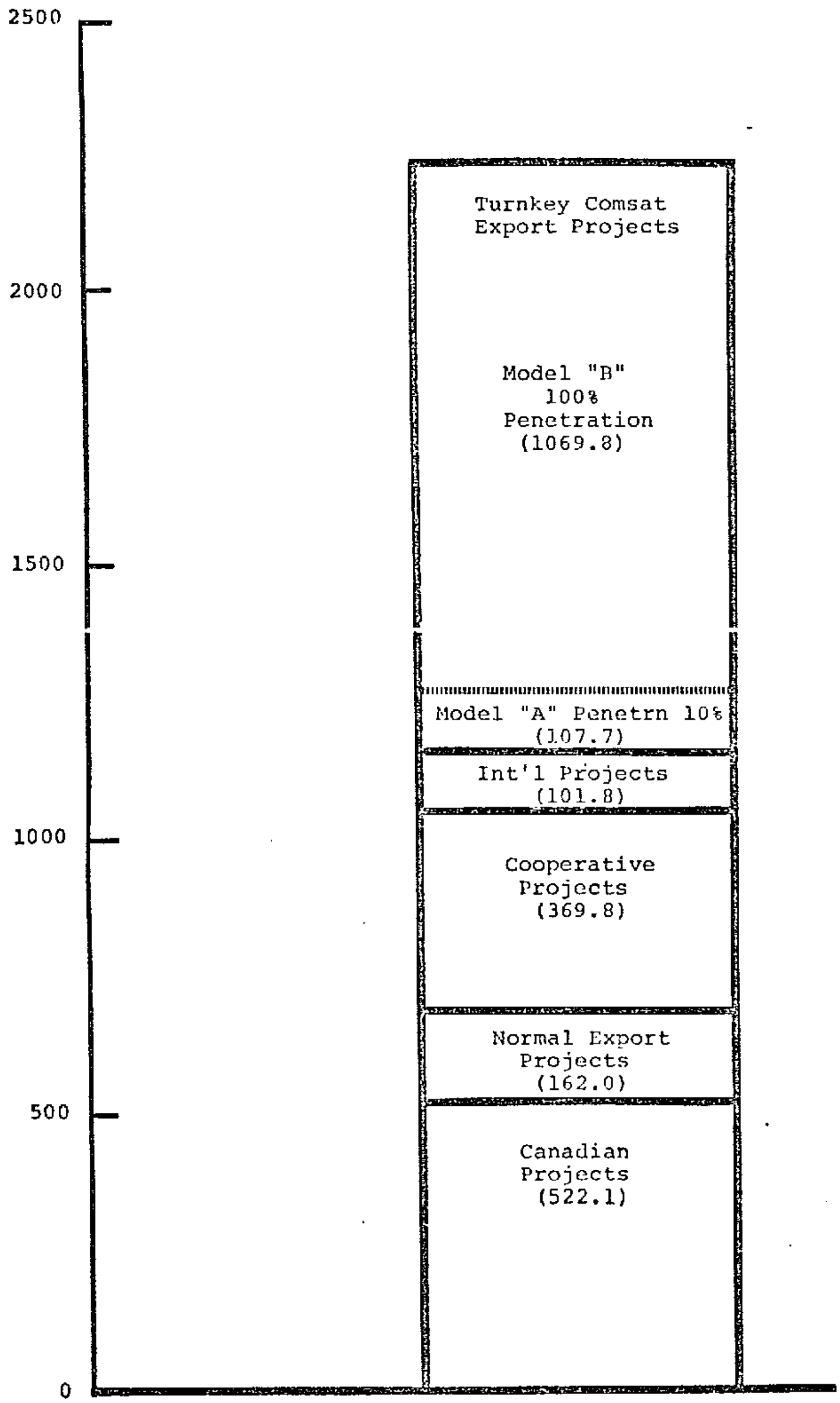

FIGURE 2

SUMMARY OF POTENTIAL SPACE MARKETS

Millions of 1973 Dollars

Market Categories	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Canadian Projects	22.6	19.1	18.7	28.2	25.8	27.5	25.2	20.8	19.5	25.7	42.3	41.7	34.3	29.7	29.3	29.7	29.3	42.7
Normal Export Projects	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Cooperative Projects	-	2.5	11.0	21.7	22.6	20.2	25.5	30.5	30.7	26.5	21.5	23.3	22.1	21.5	23.3	22.1	21.5	23.3
International Projects	0.5	2.7	6.4	15.1	13.3	6.2	1.3	2.2	4.2	5.0	10.9	8.7	3.9	2.2	4.2	5.0	5.0	5.0
Turnkey Comsat Export Projects																		
Model "A" (10%)	2.9	4.9	5.4	3.2	5.6	4.3	6.4	4.3	6.4	4.3	8.3	6.1	9.1	6.1	9.1	6.1	9.1	6.1
Model "B" (100%)	28.6	48.6	53.6	31.6	55.6	42.6	63.6	42.6	63.6	42.6	82.6	60.6	90.6	60.6	90.6	60.6	90.6	60.6
TOTAL POTENTIAL SPACE MARKET AVAILABLE																		
Incl. Model "A"	35.0	38.2	50.5	77.2	86.3	67.2	67.4	66.8	69.8	70.5	92.0	88.8	78.4	68.5	74.9	71.9	73.9	86.1
Incl. Model "B"	60.7	81.9	98.7	105.6	136.3	105.5	134.6	105.1	127.0	108.8	166.3	143.3	159.9	123.0	156.4	126.4	155.4	140.6

FIGURE 3

2/GCG/13/PG2/MO

POTENTIAL CANADIAN MARKET

Millions of 1973 Dollars

Individual Projects	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Operational Satellites																		
ANIK I	4.0																	
Telesat II				5.0	15.0	8.0	2.0											
Telesat III											13.0	12.0	5.0					
Telesat IV																		13.0
Technology Satellites																		
CTS	17.1	12.1	3.2															
VHF		2.5	11.0	18.7	13.8	4.0												
CERES					2.5	11.0	18.7	13.8	4.0									
BTV								2.5	11.0	18.7	13.8	4.0						
Domestic ATC										2.5	11.0	18.7	13.8	4.0				
Follow-on Projects												2.5	11.0	18.7	13.8	4.0		
(one every two years)														2.5	11.0	18.7	13.8	4.0
																2.5	11.0	18.7
																		2.5
Sounding Rocket Programs	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Potential Market Re: Above Projects	22.6	16.1	15.7	25.2	32.8	24.5	22.2	17.8	16.5	22.7	39.3	38.7	31.3	26.7	26.3	26.7	26.3	39.7
Contracted Out R&D		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
GRAND TOTAL POTENTIAL CANADIAN MARKET	22.6	19.1	18.7	28.2	35.8	27.5	25.2	20.8	19.5	25.7	42.3	41.7	34.4	29.7	29.3	29.7	29.3	42.7

FIGURE 4

2/GQW/11/PG2/MO

POTENTIAL MARKET FOR NORMAL EXPORT SALES

Millions of 1973 Dollars

Individual Projects	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
U.S.A. - NASA - Black Brant	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
STEM, etc.	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Europe - ESRO/ELDO) National)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Japan - NASDA	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
HS333 Type Applications	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Ground Stations	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
GRAND TOTAL - POTENTIAL MARKET FOR NORMAL EXPORT SALES	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0

FIGURE 5

2/GQW/12/PG2/M0

POTENTIAL COOPERATIVE PROJECTS MARKET

Millions of 1973 Dollars

Individual Projects	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Post-Apollo		2.5	11.0	18.7	13.8	4.0												
Other Post-Apollo Space Applications				3.0	7.6	10.4	13.8	16.2	18.0	18.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
EOS Remote Sensing						0.3	1.1	1.9	1.4	0.4								
German TV Satellite					2.5	11.0	18.7	13.8	4.0									
Other Coop Programs (one every three years)							2.5	11.0	18.7	13.8	4.0							
										2.5	11.0	18.7	13.8	4.0				
													2.5	11.0	18.7	13.8	4.0	
																2.5	11.0	18.7
Total of Above Market Excluding Post-Apollo and EOS					2.5	11.0	21.2	24.8	22.7	16.3	15.0	18.7	16.3	15.0	18.7	16.3	15.0	18.7
Canadian Industries' Share of Market Excluding Post-Apollo and EOS (50%)					1.2	5.5	10.6	12.4	11.3	8.1	7.5	9.3	8.1	7.5	9.3	8.1	7.5	9.3
Total of Post-Apollo and EOS Market; Canadian Industries' Share 100%		2.5	11.0	21.7	21.4	14.7	14.9	18.1	19.4	18.4	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
GRAND TOTAL – POTENTIAL COOPERATIVE PROJECTS MARKET		2.5	11.0	21.7	22.6	20.2	25.5	30.5	30.7	26.5	21.5	23.3	22.1	21.5	23.3	22.1	21.5	23.3

FIGURE 6

2/GQW/13/PG2/MO

POTENTIAL INTERNATIONAL PROJECT MARKET

Millions of 1973 Dollars

Individual Projects	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Aerosat		2.5	11.0	18.7	13.8	4.0												
Maresat			2.5	11.0	18.7	13.8	4.0											
Intelsat IVA Plus Options	2.5	11.0	18.7	13.8	4.0													
Intelsat V				3.20	30.0	13.0												
NATO IV							2.5	11.0	18.7	13.8	4.0							
Intelsat VI											32.0	30.0	13.0					
Follow-on Projects (one every two years)									2.5	11.0	18.7	13.8	4.0 2.5	11.0	18.7 2.5	13.8 11.0	4.0 18.7 2.5	13.8 11.0
Total Potential Market	2.5	13.5	32.2	75.5	66.5	30.8	6.5	11.0	21.2	24.8	54.7	43.8	19.5	11.0	21.2	24.8	25.2	24.8
Grand Total Potential Market Available to Canadian Industry (5%)	0.5	2.7	6.4	15.1	13.3	6.2	1.3	2.2	4.2	5.0	10.9	8.7	3.9	2.2	4.2	5.0	5.0	5.0

FIGURE 7

2/GQW/14/PG2/M0

POTENTIAL TURNKEY COMSAT EXPORT MARKETS

Millions of 1973 Dollars

Individual Projects	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
U.S. Domestic Communications Satellites																		
WESTAR	15.0	8.0	2.0															
AMSAT	13.0	12.0	5.0															
RCA Globecom		15.0	8.0	2.0														
GTE		13.0	12.0	5.0														
CML			13.0	12.0	5.0													
Second Generation Satellites (one every two years)					32.0	30.0	13.0											
							32.0	30.0	13.0									
									32.0	30.0	13.0							
											32.0	30.0	13.0					
													32.0	30.0	13.0			
															32.0	30.0	13.0	
																	32.0	30.0
TOTAL POTENTIAL MARKET U.S.A. DOMESTIC COMMUNICATION SATELLITES PROJECTS	28.0	48.0	40.0	19.0	37.0	30.0	45.0	30.0	45.0	30.0	45.0	30.0	45.0	30.0	45.0	30.0	45.0	30.0

FIGURE 8

5/GEL/18/PG2/MGO

POTENTIAL TURNKEY COMSAT EXPORT MARKETS - CONT'D.

Millions of 1973 Dollars

Individual Projects	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Foreign Commercial Communication Satellites																		
Europe	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Japan	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Brazil			13.0	12.0	5.0													
Australia					13.0	12.0	5.0											
Indonesia							13.0	12.0	5.0									
India									13.0	12.0	0.5							
Follow-on Programs Second Generation Satellites											32.0	30.0	13.0 32.0	30.0	13.0 32.0	30.0	13.0 32.0	30.0
TOTAL POTENTIAL MARKET - FOREIGN COMMERCIAL COMMUNICATIONS SATELLITE PROJECTS	0.6	0.6	13.6	12.6	18.6	12.6	18.6	12.6	18.6	12.6	37.6	30.6	45.6	30.6	45.6	30.6	45.6	30.6
GRAND TOTAL POTENTIAL MARKET - USA & FOREIGN COMMUNICATIONS SATELLITE PROJECTS	28.6	48.6	53.6	31.6	55.6	42.6	63.6	42.6	63.6	42.6	82.6	60.6	90.6	60.6	90.6	60.6	90.6	60.6
TOTAL POTENTIAL TURNKEY COMSAT EXPORT MARKET AVAILABLE TO CANADIAN INDUSTRY																		
Model "B" (10% of Total)	2.5	4.9	5.4	3.2	5.6	4.3	6.4	4.3	6.4	4.3	8.3	6.1	9.1	6.1	9.1	6.1	9.1	6.1
Model "B" (100% of Total)	28.6	48.6	53.6	31.6	55.6	42.6	63.6	42.6	63.6	42.6	82.6	60.6	90.6	60.6	90.6	60.6	90.6	60.6

FIGURE 9

5.0 INDUSTRIAL STRATEGIES

5.1 Foreword

It would appear from the foregoing that:

1. Canada is potentially a large user of spaceborne systems for communications and earth observation.

2. The degree of Canadian industrial involvement in these programs is principally a matter of Government procurement policy, rather than the action of normal market forces.

3. On a world wide basis there seems to be an over supply of "competent" space systems suppliers. Thus domestic procurement policy is vital for Canadian Industry, but unfortunately not the specific concern of the user agencies such as DOC, EMR, NRC, DND, DOE, MOT & Telesat, unless specifically articulated in their mandates.

4. Procurement policy results from a balance of many generally divergent pressures, including:

   - User departments desire to get the best system for lowest cost.

   - Balance of payments considerations.

   - The missions of such departments as DITC, MOSST and DREE, who are oriented towards developing Canadian Industry, Canadian science and technology and the distribution of economic activity throughout the land.

   - Industrial actions, either by individual companies or through trade associations.

   The resulting compromise is policy.

5.2 Strategic Options for Industry

There are numerous positions that Industry could put forward as being desirable domestic procurement policy. It should be recognized that individual companies are unlikely to agree on an exact policy; however, it should be possible to agree on a minimum baseline which would represent consensus.

5/GAY/9

A number of possibilities, which are not exhaustive, are listed below.

1. All space systems are purchased from the cheapest competent source regardless of country of origin.

2. Same as (1) above, except that Canadian industrial content - design and/or manufacturing - in the system is desirable/mandatory.

3. Same as (2) above, except that Canadian industrial content can take other forms of offset - product line transfers, etc.

4. Research, technology and preoperational space systems will be essentially executed by Canadian Industry. Operational (revenue producing) systems will be procured from the cheapest competent source with Canadian content per (2) or (3) above.

5. A complete capability at the prime contractor level be developed in Canada for all space systems.

6. (5) above, plus the development of a Canadian industrial infrastructure down to: (a) the subsystem level; (b) the component level.

7. The Government act as the design authority, prime contractor and subsystem integrator, with Canadian Industry acting at the subsystem and component level, also providing technical assistance to Government in fulfilling its role.

8. The ability to export space systems/products becomes a key to diverting procurement policy in favour of Canadian Industry for domestic business.

9. The Industry adopts a consortia or teaming approach to domestic and/or export business.

10. R & D related to space systems be contracted out only with Canadian Industry.

5/GAY/10

5.3 Preliminary Industrial Consensus

A review of the foregoing options and variations thereof have led to the following preliminary conclusions:

By a process of trial and error over the last 15 years, unstated current Government policy appears to be best represented by a combination of possibilities Number 4 and 7 in Section 5.2 above, i.e.;

Research and technology space systems projects are executed in large measure by Canadian Industry at the subsystem level. (Alouette II, ISIS I, ISIS II, CTS, Sounding Rockets)

Operational revenue producing space systems are procured from the cheapest competent source which can provide a satisfactory degree of Canadian engineering and manufacturing. (Anik)

It is felt that Government and Industry should jointly develop a plan whereby there is a progressively phased escalation of Canadian industrial involvement in Canadian space system procurements, to reach the following goals over the next five years:-

(1) Canadian Government funded research and technology development shall be exclusively conducted in Canada with the industrial sector being responsible for:

(a) Exploratory development and reduction to practice of new methods and concepts.

(b) Development of technical capability in engineering methods and manufacturing techniques.

Such work should be subject to the Government's Contracting-Out procedures.

(2) Canadian Government procurement of complete space systems for research and technology development shall be conducted through a Canadian Prime Contractor or consortium of Canadian companies who will be constrained to ensure that full use is made of the Canadian industrial infrastructure in the execution of such projects. There shall be incentives for the Prime Contractor to see that this is accomplished.

Industry shall be allowed to make use of Government facilities on favourable terms for the execution of such projects.

(3) Canadian operational revenue producing space systems procured by Crown or corporations with a Crown financial interest shall as a minimum include Canadian designed and built subsystems, with the subsystem suppliers constrained to make full use of the Canadian industrial infrastructure in the same manner as indicated in (2) above.

5/GAY/11

5.4 Industrial Structure

The development of an industrial plan in the space systems field, including an organizational structure to match that plan, is futile, unless it is harmonized with Government's plans.

This results from the fact that the degree and scope of the space systems business is dictated almost entirely by Government initiatives, both in terms of domestic procurement policy and the negotiation of favourable trading agreements with other nations as they relate to exports or cooperative projects. Thus, a cohesive industrial structure must perforce be developed as a response to Government plans. It is perhaps superfluous to suggest that if Canada can develop policy and plans to satisfy its long term domestic requirements in space, its posture with respect to international and cooperative space projects are likely to fall into place quite easily.

Conversely, a Government plan which involves Canadian Industry is doomed to failure unless the Industry's existing and planned capabilities are known to Government.

Given a Government plan, Industry will develop configurations to match that plan so that the maximum benefits will accrue to Government, users, Industry and Canada.

5/GAY/12

6.0 BENEFITS TO CANADA

6.1 An Overview

Wisely administered, the difficulties of developing space technology within Canadian Industry can be more than balanced by the return it provides in the satisfaction of Canada's declared national aims and policies.[10]

It can foster economic growth through the application of the scientific, technological, management skills and knowledge gained in the furtherance of the development of the Canadian economy generally, and specifically in the creation and operation of peaceful spaceborne systems required to satisfy Canadian needs in communications and earth observation.

The ability to design, develop and construct such systems in Canada will contribute to the safeguarding of our sovereignty and independence and will permit Canadian industrial participation in international spaceborne systems. Participation in international satellite programs has already demonstrated that the peoples of many nationalities can work together towards common objectives, and in so doing, promote international understanding on a man-to-man basis, which is fundamental to the maintenance of world wide peace and security.

An advanced social and economic entity such as Canada can only continue to satisfy the aspirations of the majority of its citizens through the maintenance of its economic position relative to other nations. The flood of young, highly trained and ambitious graduates of our universities and colleges over the next decade will not be satisfied unless they can have adequate challenges to respond to. Because of the very high technological content of space projects, these projects are probably the most economic way available today to support high technology in Canada and thus provide stimulating and challenging opportunities to our future scientists and engineers.

6.2 Sovereignty

In its broadest sense, this means that Canadians must have control over their own destiny. The course of wisdom would show Canada to be foolhardy if she were to rely entirely on foreign states for communications and earth observation systems, even within the framework of a "continental" policy. Even within such a framework, Canadians must know at least as much about Canadian resources as our partners at the time of negotiating common policies for the good of both. We believe that space systems for communications and earth observation are vital elements in preserving this control. It is therefore worth reiterating appropriate portions of paragraph 3.1:

"To assume control of and continued access to such systems implies Canadian ownership of the system, Canadian operation of the system, and Canadian maintenance of the system.

In that these systems must be designed with Canadian requirements in mind, Canadian design and manufacture of the system and many of its component parts is implied, which in turn ensures the supply of parts necessary for system operation and maintenance."

6.3 Employment

A not inconsiderable result of the economic activity suggested in the foregoing is direct skilled employment in Canada.

We are talking about:

Domestic Sales	\$ 20 Million/yr.
Export Sales	\$100 Million/yr.
Total	\$120 Million/yr.

The industries participating directly at the prime contractor level will average some \$25,000 sales per employee annually, thus resulting in the creation of some

4,800 jobs directly,

without consideration of economic multiplier effects resulting from subcontracting to domestic industry and accounting for service industries supporting the needs of these employees. This high technology activity can attract a multiplier of approximately 5:1[11] on the basic direct employment, without attempting to consider the intangible benefits to Canadian citizens at large which results from good, secure, communications and earth observation systems.

5/GAY/14

6.4 Distribution

A coordinated and wisely administered space systems activity would provide a practical regional distribution of high technology jobs and their associated services.

The Canadian space industry sector is already quite widely distributed in Canada.

Montreal	-	Aviation Electric Limited
Montreal	-	Canadair Limited
Montreal	-	RCA Limited
Montreal	-	United Aircraft of Canada Limited
Lucerne	-	Northern Electric Company
Ottawa	-	Bell Northern Research
Ottawa	-	Computing Devices Limited
Toronto	-	Dilworth, Secord, Meagher & Associates Ltd.
Toronto	-	Spar Aerospace Products Ltd.
Waterloo	-	Raytheon of Canada Limited
Fort Erie	-	Fleet Industries a Division of Ronyx Corporation Limited
Winnipeg	-	Bristol Aerospace Limited
Saskatoon	-	SED Systems Limited

The work load and economic effect would thus be felt in many areas of the land.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Overview

On an overview basis, we believe the following to be true.

1) Canada will continue to be a consistently large purchaser and user of space borne systems.

2) The total space systems market is commercially attractive to Canadian Industry provided the domestic base develops and is at least as predictable as that of other developed countries.

3) Procurement policies and procedures for domestic programs must increasingly favour Canadian sources.

4) The result will be of continuing significant economic, technological and social benefit to Canada.

7.2 Policy

On a policy basis, we believe that Canadian space policy must contain the following six elements:

1) A continuing planned program for the design, construction and operation of domestic satellite systems on approximately a two-year cycle.

2) A continuing, stable program of technological development, contracted out to Industry, in respect to certain key subsystems and component activities which relate to future Canadian requirements and in which Canadian Industry has demonstrated excellence at the international level.

3) Canadian satellite-borne communications and earth observation programs be organized tto permit management by Canadian Industry where economically feasible; and, where such is not practical, to ensure maximum opportunity for Canadian Industry to participate in both the design and manufacture of subsystems and components.

4) Canada's bilateral international trade agreements must allow continued export of Canadian spacecraft subsystems and components on a basis favourable to Canadian Industry.

5) Canadian participation in international and cooperative space systems programs should continue and be expanded, and be on the basis of pragmatic agreements entered into by Canada with its international partners, taking into full consideration the Canadian Government/Industry plan for space.

5/GGB/16

6) A clear focus of authority and responsibility for the strategy formulation and master planning of all Government space activities, taking into account the requirements of Government departments and crown companies, as well as the interests of other sectors of the community in what is most assuredly an undertaking of National importance.

7.3 Plan

Implementation requires a plan, both strategic and operational. It further requires that the plan be supported with adequate resources to ensure its success.

In addition to the normal ingredients of an operational plan, such as the establishment of the availability of human, physical and financial resources and the development of criteria for the measurement of performance against the plan, we believe that two issues within the plan must receive special attention; one is organizational in nature and the other is discipline oriented. Their resolution is considered paramount in maximizing the chances of successful execution of the plan.

7.3.1 Organization

We believe that organizational options such as the following should be examined, individually or in combination, by a senior Government/Industry group to determine the most effective method of establishing the need and capitalizing on the opportunity.

a) Government

i) The Federal line Departments manage their own space projects when they can justify the need for such projects. The central focus for overall space systems strategy formulation and master planning be provided elsewhere.

ii) A "Lead Agency" be selected to look after other Departments space related projects on their behalf and conduct the necessary overall central planning.

iii) A "Program Management" approach to the management of projects with interdepartmental interests, perhaps along the lines proposed for the management of a national STOL program. This would also include central planning.

In addition, consideration should be given to:

iv) Subsystem and component technology development being directed and funded by MOSST in

5/GGB/17

consultation with other interested departments.

v) An altered and broader role for Telesat Canada Ltd. to include the advancement of space systems technology in Canadian Industry.

vi) Contract with Industry under the make or buy program for managerial capability and services.

b) Industry

i) The traditional competition for prime/sub roles in space systems procurements.

ii) A consortia and/or "new company", approach at the Industrial prime contractor level to such procurements.

iii) A consortia, and/or "new company", approach, but including, as a member, the interested Government agency.

iv) The Prime's responsibility in developing lower tier Canadian Industrial infrastructures.

v) Under contract from Government, develop management capability.

7.3.2 Disciplines

The following necessary and sufficient conditions for the conduct of space systems projects should be given particular attention in any plan around which policy is developed.

i) The availability of forecasting data related to potential future domestic projects. Without this data, the Industry cannot respond to the requirements in a timely manner if they should develop into approved projects.

ii) Program and systems management capability. The maintenance of this capability normally requires a fairly continuous flow of related "business" to maintain it at an adequate level of competence.

5/GGB/18

iii) The development of subsystem technology in advance of forecast domestic project requirements. Currently this is not done, and the project itself bears the cost of this development work, which is a very inefficient method of conducting such development.

iv) The development of sources in Canada for qualified components. Such sources currently do not exist.

v) The facilities necessary for space segment integration and testing, and their management on a continuing basis. This again normally requires a reasonably continuous flow of similar work to maintain the capability.

vi) The trade and marketing arrangements required on a country to country basis, on a Government/ Industry basis and on an Industry grouping basis to maximize penetration of the export market.

7.4 Future Action

It is recommended that a mechanism be established between Government and Industry whereby a strategic plan may be developed with respect to space systems which will allow our country to realize the returns presented by the opportunity.

We believe that a well conceived plan, making better use of existing funds, developing a better organization of space activities within Government, and better organization of the communications between Government and Industry with respect to space activities, will not increase the overall cost of Canada's space systems efforts and will allow Canada to reap a much higher return on these activities.

5/GGB/19

REFERENCES

(1) Canadian Science Secretariat - Upper Atmosphere and Space Programs in Canada - Special Study No. 1, Queen's Printer, Ottawa 1967.

(2) Science Council of Canada - A Space Program for Canada - Report No. 1, Queen's Printer, July 1967.

(3) Drury, the Honourable C.M. - A Domestic Satellite Communications System for Canada" - A White Paper - Queen's Printer, Ottawa, March 1968.

(4) Science Council of Canada - Towards a National Science Policy for Canada - Report No. 4, Queen's Printer, October 1968.

(5) Bill C-184 - Telesat Act - Queen's Printer, Ottawa, June 1969.

(6) Lamontagne P.C., the Honourable M - A Science Policy for Canada - Queen's Printer, 1970, 1972 and 1973.

(7) Waters, W.H. - Space and Upper Atmosphere Programs in Canada - A Summary, National Research Council of Canada, Ottawa, January 1973.

(8) Interavia, February 1973.

(9) Ministry of State for Science & Technology - Scientific Activities, Federal Government Costs & Expenditures 1963-64 to 1972-73 - Information Canada, September 1972.

(10) Foreign Policy for Canadians - Information Canada, Ottawa 1970.

(11) The Space Program and its Economic Effect on the Nation - McDonnell Douglas Corporation 1973.

5/GGB/20