A BASIS FOR R&D

IN THE

DEPARTMENT OF COMMUNICATIONS

A DISCUSSION PAPER

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SUMMARY

The writer has endeavoured to present a structure for determining the role of R&D in the Department of Communications. It is a big role in financial terms. In 1975/76 it accounted for about half of the budget and 30% of the man-years. Furthermore these activities support interests which are significantly broader than those generally encompassed by the policy and regulatory sectors of the department (this is particularly true of the space and the radar research programs). It has quite frankly been difficult to find a logical structure upon which to hang the elements requiring discussion, for each element is to some extent dependent on the others. The structure finally adopted is as follows:

1. A brief discussion of why communications research is important and of the size and shape of current R&D activities is provided. The importance of Bell-Northern Research to communications R&D in Canada is also discussed. It is concluded that DOC sponsored research should as far as possible be complementary to and not competitive with BNR activity, and that there are indeed important R&D activities which fit this criterion and in which DOC should be involved. These conclusions will not be considered as revolutionary.

2. The second section goes on to discuss what the major objectives for communications R&D could or should be. These objectives are broken down as R&D in support of:

(A) Policy Development
(B) Regulatory Activities
(C) GTA Activities
(D) Research and Development as a Departmental Activity in its Own Right
(E) Research in Support of Other Departments and Agencies
(F) Other Research and Development Objectives

It is concluded that most of the objectives listed provide a valid justification for DOC sponsored R&D, but that the method of accomplishing the objectives requires further discussion, a matter which is pursued in Section 3.

The importance of CRC activities to other departments (particularly in space, radar research and HF radio propagation) is noted, as is the difficulty for the department to relate the needs of other departments to its own internal list of priorities when it is faced with decisions on the allocation of budgets and man-years. It is noted that these problems could be alleviated by the detachment of CRC from DOC, but only at the cost of creating other problems.

3. The third section starts with an attempt to highlight the importance of the policy research and the systems study activities within the department to providing the linkage between the policy and operational sectors on the one hand, and the research and space sectors on the other.

The second part of the section discusses the important question of institutional options for CRC. There is consideration given to the option of detaching CRC from the department, to form either an independent not-for-profit institution or to setting it up within NRC or an NRC-like body. It is recommended that this matter be subjected to a more searching study than was possible during the preparation of this paper. A recommendation on the method of accomplishing this important task is contained in this section.

The section ends by developing the concept of R&D themes as a means of relating the objectives for research discussed in the previous section to current policy objectives. The theme concept is similar to the existing method of categorizing R&D activities for the purposes of operational plans, although some changes are suggested.

The most important of the proposed changes is the suggestion that most applied research and oriented basic research activities be grouped as a separate theme and assigned a fixed percentage of the R&D budget. This step would help to highlight the rather different nature of such activities from the bulk of the work currently in progress at CRC, and avoid misunderstandings which tend to arise when this research is laid upon the various Procrustean beds represented by the other, more conventional, themes.

4. In the fourth section the writer has listed six themes under which he suggests R&D might be categorized. These themes will hopefully provide a basis for discussion. It is not expected that they will necessarily be accepted as listed. The six themes are:-

Theme 1 - Policy Development Studies
Theme 2 - Support of Regulatory Activities
Theme 3 - R&D as a Policy Instrument
Theme 4 - Space
Theme 5 - Applied and Oriented Basic Research
Theme 6 - Research and Development Undertaken for Other Departments and Agencies

5. A short section on make or buy options is included, although in fact much of the discussion related to this subject is scattered through the paper wherever it is relevant. It is clear that DOC has an enviable record relative to other departments regarding the execution of Make or Buy policy.

6. The last two sections deal briefly with the important problem of measuring the effectiveness of R&D, and discuss several matters brought to the writer's attention late in the preparation of the paper, notably the possibility of Canadian membership in the European Space Agency.

This report tackles some of the issues raised by the report of the Communications Research Advisory Board (CRAB), and is in the writer's view, complementary to it. For a variety of reasons, of which the CRAB report is an important element, the coming year shows promise of being one in which the department will come to terms with its research role in a way which will leave administrator and researcher alike with a common understanding of its R&D objectives in both the shorter and longer term, an understanding which will provide a firm foundation on which to build R&D programs. The writer hopes that the ensuing pages will contribute to the realization of this objective.

In 1971, Philip Lapp prepared a report entitled "The Communications Research Centre - A View from Outside". On page 28 he described what, in the writer's view, remains as the central problem at CRC, i.e. a lack of research goals which are clearly understood by both scientists and senior management. Dr. Lapp expressed it in the following way:-

> "Given a set of clear-cut objectives and adequately motivated people, the success of any enterprise becomes almost independent of its organization or hierarchial structure. If there are organizational difficulties at CRC, most likely they would spring from a lack of well understood goals and objectives, because the writer found during the interviews no lack of motivation on the part of the people contacted. Indeed, it would be hard to find as talented, highly skilled and conscientious a group of people elsewhere in the government, with such an enviable record of successes. At DRB, goals and objectives probably were reasonably well understood; and in those days, governmental scientific research <u>per se</u> was held in much higher esteem by budget authorities than it is today".

A major pillar of Dr. Lapp's edifice of proposed solutions was the recommendation for the formation of a Planning Directorate at CRC. The writer is of the view that an important current source of misunderstanding is the existing set of R&D priorities or themes, which tend to be interpreted differently by people with different backgrounds, hence some changes in theme structure have been recommended.

The research and space sectors can and do render valuable service to policy formulation through system study activities, which, in some sense, provide a bridge between

normal headquarters preoccupations and the more traditional research activities. The central, inescapable fact is, however, that CRC is primarily, as Lapp puts it, "...a technological establishment organized and geared to accomplish technical objectives, and with an enviable record including four [now five] successful research satellites". DOC can, and does, usefully employ some of this capability to support its narrower policy and operational objectives. However the R&D budget of the department is out of all proportion to the use that DOC makes of CRC in this manner. If it is the view of senior management that the direct support role is the only viable role for CRC to play, then CRC should, in the writer's view, be transferred from the department (hence the recommendation that alternative organizational structures be considered). If, on the other hand it is believed that the significant contributions that CRC is making in terms of technical development are ones which the department would like to support and foster as part of a national resource, then CRC can, in the writer's view, continue to be effective within DOC.

It is important however that the decision, one way or the other, be taken clearly and explicitly, and, once taken, communicated widely.

RECOMMENDATIONS

This report is not laced with a large number of recommendations, but rather tries to sort out the proper role of R&D in the department. Nonetheless, the writer did note areas where he recommends that changes be made:-

1. It is recommended that the themes about which R&D activities are organized be altered so as to permit greater understanding by both researcher and manager alike of the nature of the contribution that research can be expected to make. A revised set of themes has been suggested in Section four.

It is further recommended that a new theme, entitled "Telecommunications Applied and Oriented Basic Research", be included, this theme to comprise the quasi-totality of R&D activity which is neither exploratory development nor specifically related to policy development. This theme should be funded on the basis of a fixed percentage of the total R&D budget. The current figures of about 27% of the budget and 40% of the man years dedicated to such activity may be appropriate targets. (cf p. 27)

2. It is recommended that the department examine carefully and in depth the possibility of organizing the communications research activity into a not-for-profit institute or an NRC-like body. (cf pp. 25-26)

3. It is recommended that a somewhat more formal method for coordinating communications R&D expenditures by the several different Federal government departments and agencies be put in place. (cf p. 19)

4. Examination of communications R&D expenditures by the Federal government relative to its R&D expenditures in other areas, reveals communications R&D funding to be relatively modest. It is recommended therefore that consideration be given at the appropriate time to increasing government support of communications R&D. (cf p. 12)

INTRODUCTION

On April 1, 1969 the Defence Research Telecommunications Establishment (DRTE) was formally transferred to the newly formed Department of Communications and became, under its new name (the Communications Research Centre), a major element in the new department. Thus a research centre with a well established scientific reputation in international and particularily NATO circles, and an established reputation with the Canadian public, (largely as a result of the Alouette and ISIS satellites) became overnight a major part of a new department which had a mission as yet unclearly defined, but assuredly very different from that of DND.

The adjustment to the change has been difficult for scientist and bureaucrat alike. With the exception of the space program which gained, at least temporarily, a special project status, the attempts of those at Shirley Bay and at Headquarters to define mutually agreed "relevant" research programs appear to have been discouraging.

The writer of this paper is not, he hopes, under any illusions as to particular insights he might have on the difficult question of defining a mission for research and development within DOC. He has tried, however, to assemble in one paper the basic facts necessary for a consideration of the problem, and to present his own conclusion arising from those facts.

Out of the debate which the writer hopes will be stimulated, should come some clear directions for the pursuit of research and development by the Department of Communications.

1. WHY SUPPORT COMMUNICATIONS R&D?

Even the simplest of problems has a nasty habit of drawing the enquirer back into more fundamental questions. Thus, any answers to the question of whether or not DOC should participate in research and development, and if so, in what kinds of R&D, are bound to depend to some extent on the perception of the person answering as to the importance of communications to society, the goals of society itself, and a host of other questions.

To some extent, the eternal debate on such questions is muted by the passage of legislation, which establishes a consensus for action at a given point in time. However legislation is usually generally worded, precisely to permit its continuing utility in the face of changing circumstances, not the least of which, quite naturally, are changes in the leadership of the department or agency responsible for the legislation.

If one examines the Department of Communications Act (c.f.Appendix I), one reads such "duties" as "[to] promote the establishment, development and efficiency of communication systems and facilities for Canada" (Sec 5.(1)b). The Radio Act approaches the research question more directly as follows (Section 8(2)a):

"The minister shall undertake, sponsor, promote or assist in research relating to radio communication including the technical aspects of broadcasting".

Likewise the objectives of DOC as set out in the Main Estimates (and reproduced with further disussion in Appendix II) contain such phrases as "... foster, develop and introduce new communications systems,..."

As one frustrated scientist put it to the writer (quoting sequentially the departmental objectives), "How can new communications systems be fostered and developed without research? How can the Canadian interests in international telecommunications systems, services and undertakings be protected and sustained without research? or How can the utilization of the radio frequency spectrum be improved and extended without research?"

Even if the questions thus phrased yield universal agreement on the necessity for research, this agreement of itself is not overly helpful, for, as in any organization, the real answers come when resources are allocated to each activity, not when the questions are answered in principle.

There is no avoiding of the basic issues then. It is not enough to agree that communications R&D is important.

One must attempt to come to grips with the very much more difficult question of how important it is, which leads us back to our perception of the importance and role of communications in society.

We are going through a strange and fragile period. The old goal of economic growth, the basis of so much of our policy in the past, no longer provides a single hypnotic focus. It shares the field with "zero growth", "conserver society", and a host of "socio-economic" goals some of which are conflicting and most of which are difficult or impossible to use in a normative sense.

The following statements however provide some basis for paying particular attention to communications, and particularly to communications R&D.

1. Whether one believes in greater centralization or greater decentralization of control of society, an efficient telecommunications system is essential in either case. (Clearly in a decentralized society it will be vital that individual organizations have quick access to the activities of others so that they can regulate and coordinate their activities appropriately. The requirement for efficient communications in a centralized society is even more obvious.)

2. Telecommunications have a strong influence on the stability of society, and can act either to stabilize or destabilize it. (An example of destablization is when media advertising results in raised economic [or other] expectations when there is no means for satisfying such expectations. On the other hand, as a stabilizer communications can provide us with the essential feedback information on the results of our own and other's activities, thus allowing us to react appropriately before over reaction becomes an attractive option.)

3. We have much to learn about the circumstances in which telecommunications reinforce or reduce societal stability, and in the ways that telecommunications affects achievement of other agreed upon goals. Recent studies on the effect of TV violence provide but one example of urgently needed research. To raise yet another example, we have yet to come to grips with the effects on social cohesion of nearly unlimited choice for the TV viewer.

4. Communications services are generally better in urban areas than elsewhere in Canada, and the gap in availability of services continues to widen (although there has been a great improvement in the telecommunications services available in some remote areas). Canada amongst the "developed" countries, has some particularly acute problems in this respect.

5. Utilization of the radio frequency spectrum is increasing at an accelerating pace, calling for increasing ingenuity in the allocation and assignment of frequencies. The phenomenon is no respecter of national boundaries, and results in highly technical and complex international negotiations.

6. Telecommunications technology is advancing rapidly (and probably will continue in a similar vein for another twenty years or so). Space and computer technologies are just beginning to have a real impact, glass fibres and videodiscs are not far behind. Each halving of the cost of employing such technologies yields a vastly enlarged set of applications which become economic.

7. Major changes in the cost of telecommunications components (which result in the development of new services or in lower prices for existing services) can and in some cases do lead to changes in lifestyle, changes in institutional allegiances, and sometimes to changes in the institutions themselves.

8. The telecommunications industry, with gross revenues on the services side of about $2.6B, and on the manufacturing side of about $1.2B accounts for some 4.3% of the gross national product. The telephone companies have an estimated depreciated plant investment of $7.2B (with a probable replacement cost of about $10B) and their annual capital investment in 1974 was approximately $1.0B. Thus the telecommunications industry is important in its own right as an employer and contributor to Canadian economic well being. Furthermore the very large investments in "buried" plant by the telephone companies means that any new technology which cannot be integrated with existing plant will have only limited application.

These eight statements are by no means definitive of the importance of telecommunications, but they do suggest some important reasons to undertake telecommunications R&D, and concurrently suggest directions the R&D activity might take. For example:

(a) Under the umbrella of statement 3 regarding the effect of telecommunications on the stability of society comes a host of problems primarily related to the content and variety of broadcasting services, but including such issues as the effect (if any) on national unity of raising long distance telephone rates in order to subsidize local (fixed price) calling.

(b) Statement 4 opens important areas for both policy and technical research to find practical ways to narrow the telecommunications services gap between urban and non-urban areas.

(c) Radio frequency spectrum crowding points to research on ways of improving the efficiency of spectrum useage, as well as finding viable alternatives for current spectrum users where this is possible. Included in this category is propagation research particularly at the higher, as yet relatively unused frequencies.

(d) New technologies bring new opportunities and new problems. It is important that Canada retain sufficient competence in these new technologies to enable her to recognize potential opportunities and problems in time to take appropriate action. This competence needs to be available (in different form) to the industrial sector, the service sector and the government sector.

While the foregoing may have convinced the reader that telecommunications in general, and telecommunications research and development in particular are important, we do yet need to identify some quantitative measures of what level of communications R&D activity might be appropriate generally, and in particular what level of federal government R&D expenditures might be appropriate.

Of course, government expenditures generally, and R&D expenditures in particular traditionally work on an incremental basis, a given activity receiving upward or downward increments depending on the assessment of relative priority made. It is important though, to be aware of some gross magnitudes relevant to communications R&D. The following facts seem relevant:-

(1) It is estimated that expenditures in communictions R&D in the industrial and the federal government sectors were $120M and $50M respectively in 1974.* About $36M of the government total was expended by DOC (much of it in industry). A further $5 1/2 to $6M were in the form of grants to industry under such programs as IRAP, PAIT, DIP and IRDIA.

(2) According to the latest (1974) Canada Year Book, in the 1973-74 fiscal year DOC R&D expenditures accounted for 4.2% of federal government R&D expenditures. The 4.2% DOC figure compares with 13.3% by the Department of the Environment, 17.8% by NRC, 10.4% by the Department of Agriculture, and 5.8% by the Department of Energy, Mines and Resources.

*DOC Brief to the Senate Special Committee on Science Policy - July 1976, pp. 12-13

(3) Bell Northern Research dominates the commercial telecommunications R&D scene in Canada with expenditures of $49M in 1974 and an estimated $57.1M in 1975. This laboratory has an impressive record of developing commercially successful communications equipment. Northern Telecom is competing successfully in international markets, fed largely by BNR development products. Any federal government R&D program must take cognizance of the presence of BNR.

(4) The statistics on DOC expenditures on communications R&D require some qualification. A very large percentage (about 75% in 1975/76) of R&D expenditures are in the space sector. But the space capability has wider application than just communications. Applications in land and sea surveillance (e.g. Landsat, Seasat), search and rescue (SARSAT) and aerial navigation and control (Aerosat) are in various stages of active consideration and study within DOC (as well as by other departments concerned), although a major fraction of recent expenditures has, of course, been in connection with the Hermes satellite. Research in radar is another important activity at DOC (although 95% of the man years are funded by DND). Important though the radar activity is, it is scarcely communications R&D in any traditional sense of the word. Technical R&D at DOC, other than that in the space sector and that funded by DND, accounted for only 20% of departmental R&D expenditures.

The author draws the following conclusions from these statistics:-

(1) In the Bell-BNR-Northern Telecom complex, Canada has a highly integrated and successful organization. Bell Canada while a major customer of Northern Telecom is only responsible for about 44% of its business, thus avoiding many of the unhappy consequences of too dependent a relationship. Quite naturally and properly, BNR activities are concentrated on activities likely to result in a high economic rate of return.

Much as it has done in the past, DOC should avoid head on competition with BNR by:-

(a) Directing its own R&D activities (particularly its exploratory development work) to areas with relatively lower financial returns and relatively higher need for support in the public interest (such as satellite, rural and remote communications).

(b) Endeavouring to direct its oriented basic research and applied research activities so as to be helpful to future exploratory development work at BNR and other Canadian commercial labs.

(2) The success of BNR will be taken by some as a sign that federal presence in communications R&D can be correspondingly reduced. Indeed, there are strong signs that this has already happened, since our expenditures in communications research other than space is small both in absolute terms (about $6M at DOC) (see table II of Appendix 3), and in relative terms (see comparisons with other departments on p. 10 and in Appendix 3). Another strategy, one which is favoured by military strategists, is to reinforce strong suits. Given the importance of good telecommunications to all mankind, and the particular technical challenges which Canadian geography and demography present, and given our established industrial capability, there would seem to be good argument for government backing and reinforcement of communications programs which are well conceived and meet government objectives.

Thus, although the writer is aware of the pitfalls inherent in recommending increased expenditures in one subject area before surveying those areas at whose expense such an increase might come about, he nonetheless believes that on the basis of the importance of communications research and development and its modest funding relative to other subject areas, there is a good case for, at the very least, maintaining federally supported communications R&D expenditures at their current level, and planning for an increase in expenditures when economic circumstances permit.

2. R&D OBJECTIVES FOR DOC

In this section a number of actual and potential R&D objectives for DOC are examined.

(A) Policy Development

Under the Department of Communications Act, the Minister is required (Sec. 5(1)(a)) to "coordinate, promote and recommend national policies and programs with respect to communication services for Canada.....". The more complex our society becomes, the more study is required to understand the full implications of any new policy. Such studies typically require information related to a variety of disciplines, and may or may not require research in the more generally accepted sense of the word.

Policy research has only relatively recently become a term in widespread use, due in Canada perhaps to the efforts of the Lamontagne Committee and the recent foundation of the Canadian Institute for Research in Public Policy. The Ritchie report which led to the establishment of the institute, defined its mission (and by inference defined <u>policy research</u>) as

"<u>.....research and development designed to improve the basis for informed choice and decisions by the public of Canada and its leaders on questions of public policy</u>".

Clearly there is but a fuzzy boundary between policy development, policy study and policy research. In practice, the line is drawn in terms of the effort involved. Studies which require complex analyses and tradeoffs are more likely to be termed "research", as too is the more generalized activity of developing techniques for performing policy research.

These days, policy research is necessary for all but the most trivial of policies and programs, and must therefore rank as an important activity for DOC to undertake itself or to contract or sponsor. The extent to which it could or should opt to do the needed research internally will be discussed later under the section on R&D organization.

The sorts of questions to which policy makers need answers and which require background research in varying degrees are:-

- The impact of the next generation of satellites on northern communications.

- Rural telecommunications needs.
- The role of the Post Office and of the common carriers in the electronic mail business.
- The development of new services into the home.
- Possible institutional changes in the urban environment (common carriers, CATV, broadcasting).
- RF spectrum utilization forecasts and spectrum conservation techniques.

(B) Regulatory Activities

The proper administration of the Radio Act requires that the department be in possession of technical information related to radio wave propagation and the expected or actual performance of radio communications systems. The sorts of specific questions which need answers are:-

- Can the capacity of an existing frequency allocation be increased by using polarized signals or through more efficient coding methods or by some other technique?
- What propagation problems are likely to be encountered in using higher frequency (over 10 GHz) microwave systems in terrestrial and space applications?
- What is the R.F. noise environment like, and what are the sources of noise?

Answers to these questions require a mixture of applied research and systems studies, the former concentrating on the theory and practice of radio propagation, and techniques for efficient and effective signal transmission, the latter on answering the more general questions related to the performance of radio systems, and the requirements which they must meet.

(C) GTA Activities

In the past, GTA activities have not resulted in much demand for research and development, although there has been cooperation over the teleconferencing project. Some government departments have come directly to the

Communications Research Centre seeking advice and assistance in areas where CRC had particular expertise. Often the expertise was not directly related to a service provided by a common carrier (which is of course where GTA focuses its attention).

Except possibly on those occasions when a major change to the government telecommunications network is anticipated, it seems unlikely that there will, in the future, be significant R&D activities related to GTA operations.

(D) Research and Development as a Departmental Activity in its Own Right

Herein lies one of the more difficult questions requiring re-examination.

It seems fairly clear that in its original conception of the department, the government did envisage that DOC would undertake R&D other than to meet the needs of policy development and regulatory activities. The DOC Act itself (which is only two pages long (cf Appendix I)) makes no clear reference to R&D, but it leaves the door open with the following item on the list of ministerial duties: "[to] promote the establishment, development and efficiency of communications systems and facilities for Canada". The Radio Act is much more explicit, containing in section 8(2) (as already partially quoted) the following words:

> "The Minister shall
>
> (a) undertake, sponsor, promote or assist in research relating to radiocommunication including the technical aspects of broadcasting, and
>
> (b) encourage the development and more efficient operation of radiocommunication facilities in Canada,

for the purpose of improving the efficiency of radiocommunication services and increasing their usefulness and availability in the public interest."

The objectives of the department as contained in the Main Estimates (and reproduced in Appendix II) also, by the use of such words as "... foster, develop and introduce new communications systems, facilities and resources" strongly imply the use of R&D directly as an instrument of policy, that is, as a means of furthering departmental objectives, and not merely as a service to the policy and regulatory sectors of DOC. As concrete evidence of this view, the Defence Research Telecommunications Establishment was transferred to become a founding element of DOC as the Communications Research Centre.

This initial enthusiasm does not, of course, preclude a re-examination of this decision to marry operations and policy with R&D activities. Indeed, there are now some signs of a "seven year itch" which would make such a re-examination appropriate. There are two questions involved here, and they need to be clearly separated. They are:-

(1) Should the DOC support broadly based communications R&D (regardless of whether it is done in-house or contracted out), and

(2) If it is decided that DOC should continue to answer 1) above in the affirmative, does it need to maintain a sizeable research sector of its own?

Of course, if the answer to either question is negative, there is a third obvious question to face, i.e. What does one do with CRC?

The writer is of the view that DOC should continue to support R&D which is consistent with carrying out its objectives as currently stated. Support of R&D is a high synergy tool for steering developments in the desired direction, though its end results are hard to guarantee. Regulation and legislative decrees although more certain of achieving their primary objectives, are far more likely to exacerbate differences of opinion and lead to non-productive confrontations. The importance of communications to Canada, and the complexity of the problems to be confronted, strongly suggest a need for both kinds of policy instruments.

The supplementary question of whether or not DOC should continue to maintain its own R&D establishment or merely act as a funding agency is one requiring careful consideration. Some discussion of this question is to be found in Section 3.

(E) Research in Support of Other Departments and Agencies

The Defence Research Telecommunications Establishment (DRTE) was transferred to DOC upon the formation of DOC in April, 1969. The terms of the transfer were the subject of an exchange of letters between Messrs. Kierans and Cadieux (attached as Appendix IV). Under the terms of the transfer, "The DOC has responsibility for planning and executing a communications research program adequate to the national need. It will not, therefore, ask other departments to support research programs at DRTE."

The overall tenor of the agreement is, perhaps best captured by the following quotation:-

"While the principle of relying on a communications research program formulated and conducted by DOC is accepted, there is considerable concern in DND that the level of research related to defence matters may decline and the ability of DOC to supply the required consultation, assistance and innovation may also decline."

Clearly DND has been relying on CRC to provide it with an awareness of current communications developments. Indeed a primary task of the old DRTE was to keep abreast of the state of the art. As an important user of communications DND had, and still has, a vital need for such a service. Several other government departments share this need to a lesser degree.

As a policy maker in communications, but not a major user of communications, DOC also has a need to keep abreast of the state of the art. However the technical information needs for policy formulation, though related, are different from the needs of an advanced user. For example, while DND needs detailed advice and assistance for the development of communications systems using fibre optics or satellites, DOC's policy needs relate more to a general knowledge of the probable timing and economic impact of these new technologies. Both types of assistance can, but need not necessarily, come from the same institution. DOC's natural stress on budgetting to meet its own needs, has made DND nervous that it will be increasingly unable to obtain the sort of general technical advice it needs and thought it was going to get over and above the specific tasks for which it contracted CRC to provide.

There are real economies in combining the communications R&D requirements of all departments in a single organization, and there are some benefits that accrue to DOC by being in control of that organization. But any move to centralize has its price. In this case the most obvious price is the difficulty of the department, stretched as it is to budget for its own narrower (i.e. regulatory and policy related R&D) requirements, to adequately provide for a "communications research program to meet the national need", as stipulated in the transfer agreement of DRTE to DOC and implied by the Radio Act and the DOC objectives.

The case of radar research is a special example of this. According to the transfer agreement we have an obligation "to support research related to civil radar interests", even though radar is only of marginal relevance to communications as it relates to the departmental mandate. As a result, it is exceedingly difficult for departmental

management to decide on the extent of support appropriate to this field of research.

There are a number of practical solutions to this problem, ranging from a renunciation of the broader R&D responsibility by DOC, through to renunciation of CRC as a DOC responsibility. Whatever the solution, it is clearly a problem requiring frank discussion at senior levels with the departments involved.

This matter is, of course, different from the question as to whether or not CRC should undertake fully funded R&D on behalf of other departments. Quite apart from its current obligation to do so for DND, the writer believes that there is a strong case for continuing cooperative arrangements in this form provided adequate man years can be made available.

(F) Other Research & Development Objectives

Several other objectives for research at DOC have been suggested from time to time. While the writer does not believe that these objectives are sufficiently well founded to stand on their own as primary objectives for research, they can, on occasion, provide a secondary reason for the desireability of pursuing a particular research project.

Some of the objectives falling into this category are as follows:-

(i) Research and Development which is supportive to the Canadian Communications Industry

As far as can be determined, the department does not have a mandate to perform or finance research with the primary objective of supporting industry, although such support may well be a means to achieving its formally stated objectives.

As a <u>primary</u> objective for research in DOC, therefore, support to the communications industry must rank as a non-starter.

Nonetheless, in a world where no department is "an island unto itself", it would be counter productive from an overall government point of view to ignore the possibility of helping IT&C to carry out its mandate where appropriate. (It is worth noting that the Space Sector has approval to spend $12.5M over five years to develop sub-systems in industry). In this context, the appropriateness of the activity should be clearly circumscribed by those primary objectives for research agreed to as appropriate to DOC. This overlapping of objectives highlights the utility of

forming a body which examines total government support to the telecommunications industry. (IT&C and NRC contributions were estimated at well over $2 million each in 1975/76.)

It is therefore recommended that ways of coordinating R&D expenditures in telecommunications between Federal government departments and agencies be examined.

(ii) Critique of Carrier Offerings

This research objective can be more precisely identified as research and development aimed at providing a capability to judge and to criticize new carrier service offerings or to provoke the offering of new services which in the Department's view should be offered. It is not easily separable from research in direct support of policy formulation and regulatory activities, but has been singled out for particular mention primarily for historical reasons, for it has been suggested that such research is essential for governments to perform on the grounds that the common carriers can and do make expensive mistakes (the Picturephone fiasco in the U.S. is the most frequently quoted example) which are reflected in the telephone bills subscribers pay. Governments should perform research (so the argument runs) aimed at preventing such waste and helping to focus the carriers on potentially more valuable services.

While it is undoubtedly true that, as with all institutions and individuals, the carriers make mistakes, it would, in the writer's view, be a mistake for government to rush in to provide a second opinion. While government optics may be untainted by crass considerations of commercial gain, the government has no monopoly on being right. Moreover it is to be noted that in the case of Picturephone development, it is usually judged a failure <u>because of</u> its lack of commercial success, and few would dare to judge government researchers better qualified to judge potential for commercial success than the common carriers!

The writer's rejection of this objective for research should not be interpreted to imply that potential and actual carrier services should not be examined under any circumstances. There are frequently important policy or internal government reasons for examining a service offering, in which case the justification would be made on different grounds.

Current examples which illustrate the point are:-

(a) Research into the proposed packet switched data service offerings of CN/CP and TCTS with a view to taking

appropriate action with respect to problems of interconnectability and international standards, and

(b) Research into teleconferencing (now completed), computer conferencing and image communications all of which, as well as being actual or potential service offerings, are or could be important adjuncts to effective and efficient operation of the government, as well as helping to "foster new services and systems".

In summary, although the ability to critique common carrier service offerings may be a useful by-product of research with another primary objective, it is not recommended that research be undertaken with the express intent of providing such an ability.

(iii) Research aimed at training and maintaining on staff those with the needed training to perform (at a minimum) research in support of Policy and Regulatory Activities

It is most unusual (especially in the physical sciences) for researchers to go directly from their university training into policy research. Both systems and policy research activities are normally reserved for those who have already gained considerable breadth in their field and who have shown a particular aptitude for comprehending and applying a variety of disciplines to problems which frequently have economic, technical, practical engineering, institutional and social aspects.

Since people with the breadth of training necessary cannot be hired directly upon completion of university training, they must either be trained in the department or hired away from other organizations. For those with technical (as opposed to social or economic) specialization, by far the largest source for manpower is Bell-Northern Research and the companies which own it, Bell Canada and Northern Telecom. It is generally helpful, and even important, that some of our policy researchers should have obtained their training at BNR which is, after all, one of the world's better known communications research laboratories. On the other hand, the dangers of too great a reliance on the Bell family are evident. Whether or not the department is, in fact, "captured" by those whom it helps to control, it is certain to be accused of this cardinal sin should there be too high a proportion of ex-BNR staff developing policy in DOC.

Given the difficulties of recruiting outside Canada, it is important that DOC maintain sufficient applied research and development activity to ensure an adequate future supply of the researchers required to support the policy and regulatory responsibilities of the department. Those

responsible for hiring and career planning will need to identify early those with a systems research capability, and help them to obtain the breadth of knowledge required prior to transfer to policy research positions.

Thus, although it is to be hoped that applied research and development activities within DOC will continue to be of sufficient scope to ensure an adequate supply of internally trained systems researchers, so that the objective of training does not become a primary research goal of its own, it should be noted that should research at DOC fall below this critical level, there could be a problem of training personnel with the required qualifications. This problem would to a great extent be alleviated if a not-for-profit research organization were to become both a primary source for contracted research and a source of policy researchers for DOC at one and the same time.

3. SOME COMMENTS ON ORGANIZATION

(A) Systems Research and Policy Development

The objectives for R&D just described fall generally into two categories - those which are supportive of internal activities (policy formulation and regulation), and those which are outward looking and have a much looser relationship to policy formulation and regulation. It has been suggested already that the latter category of objectives can but need not be met making use of an in-house research organization. On the other hand, it is clearly important for the department to retain a research capability to meet its policy formulation and regulatory needs, although even these activities can be partially met using outside contracts.

The research specialties which it is essential to maintain within DOC are those of policy research and systems research, for it is these capabilities which are needed to provide well considered answers to a number of policy and regulatory matters. Practitioners of these disciplines normally come from a variety of backgrounds and share a common interest in trying to integrate their particular specialty into a broader context requiring consideration of social, economic, legal and institutional as well as technical constraints and possibilities.

A systems researcher, as the name implies, is interested in both the analysis and the synthesis of systems, where a system is defined as an assemblage or combination of things or parts, forming a complex or unitary whole. Policy research has already been defined on page 13 as "... research and development designed to improve the basis for informed choice and decisions by the public of Canada and its leaders on questions of public policy".

Systems research is often needed to help answer policy questions. For example, a systems researcher might seek answers to the following questions:-

- What is the potential effect of satellites on Canada's long distance telecommunications networks?

- How are new technologies likely to effect rural telecommunications systems?

Indeed for many policy problems, the disciplines of policy and systems research become almost indistinguishable. Together they form the vital link between the operational segment of the department and the research segment. Both will normally be engaged in a melange of longer and shorter term projects. By training and inclination they will move

fairly easily from one systems or policy problem to the next, and the more able practitioners will increase their effectiveness by encouraging in-house research consistent with their requirements for information and by supervising outside contracts to broaden their own and the department's perspective on important and highly technical matters.

There should then be a close working relationship between the policy researchers (in the policy sector) and the systems researchers (in the research and space sectors). The former, in turn will be involved to a greater or lesser extent with day to day operational matters (such as replies to ministerial correspondence) while the latter will be involved with drawing on the knowledge of in-house and external technical researchers.

A noticeable inconsistency becomes apparent at this point. It has often been observed that the department has no research arm examining social issues related to telecommunications to correspond to its technical research arm. At the present time, the Social Policy Branch is endeavouring to fulfill this function as well as its two main functions of responding to day to day operational pressures and performing its share of policy research. In the writer's view this mix of responsibilities must inevitably lead to the downplaying, if not the virtual disappearance of at least one of these three roles. A parallel situation might appear to exist in the area of economic policy, but here it seems that the economic research needed is by and large much more closely tied to policy and regulatory matters than is the case for social research. This subject is not within either the writer's field of expertise or his responsibility, but he does believe that questions of telecommunications social research are deserving of more attention than they are currently given.

(B) Does DOC Need CRC?

At this point it is timely to consider some of the factors which might influence a decision on whether or not DOC should continue to administer CRC. There appear to be three major options for CRC, i.e. (a) status quo, (b) its conversion into a not-for-profit institute (along the lines of the Mitre Corporation or the Stanford Research Institute) or (c) adoption of an NRC-like status (either within NRC or outside it).

(a) The Status Quo - CRC as Part of DOC

Some considerations in favour of the status quo are:-

(1) It permits a close coupling of R&D activities to the policy and regulatory activities of the department.

Thus the latter have swift access to technical expertise when needed, while the former are kept aware of departmental priorities.

(2) It helps to give the department a positive, progressive image, and permits it to lead by doing, rather than simply legislating and regulating.

(3) If the department were to continue to fund R&D activity, it would, in any case, continue to need specialist talent to select and monitor research contracts. Hard experience has shown that the advice and assistance of good scientists is vital if the funds are to be contracted effectively. Although it is sometimes possible to find good scientists ready to abandon research, in general, in order to be able to employ good scientists in a consulting capacity it is necessary to provide them with research work to do. Thus, to be able to administer a research program effectively, it is necessary to have some in-house research activity. (In the late 1960's the U.S. Air Force completely reversed its previous decision to build down its research laboratories at Cambridge and Wright Patterson because of an enforced realization of this necessity).

(4) Although it is a "bureaucratic" argument, it is nonetheless true that without an R&D arm, the department would consist simply of a small policy formulating head attached to a regulatory body with GTA clinging to one side. In government organizational terms there might be a strong tendency to dismember the department totally, perhaps moving GTA to DSS, radio regulation to MOT or CRTC and the policy head to MOT or the Secretary of State. This would be perfectly satisfactory if one did not accept the basic premise underlying the department's creation that communications are important enough to warrant a separate department. It will already be clear to the reader that the writer cannot accept that such a down playing of communications would be advantageous at this time.

(b) CRC as a Not-for-Profit Institution

Arguments in favour of creating of CRC a not-for-profit institution are:-

(1) The activities at CRC, particularly in space and radar R&D are of much broader than just departmental, or even governmental interest. A not-for-profit institution would be able to accept contracts from common carriers without much R&D capability of their own such as Teleglobe Canada, CN/CP Telecommunications, as well as from other government departments such as DND, EMR and DOE.

(2) Such an organization would not be hampered by the multifarious regulations and restrictions which government departments are heir to, and which make management of scientific personnel particularly difficult.

(3) Through a variety of contractual arrangements, the institution could provide many of the consultative and R&D services which DOC requires.

(4) The institution could more easily assign priorities equitably as between the needs of, for example, DOC, DND and DOE. At present it is extremely difficult to assign a priority to radar research for example, since it has little if anything to do with communications. The problem is not simply one of finding funds from other departments to support such work, for scarce man years are also needed in most cases. An institution would presumably be subject simply to a funding restriction, without a host of ancillary constraints.

Perhaps of greater importance than the example of radar R&D is the example of space R&D, which, as previously mentioned consumed 75% of the departmental R&D budget in 1975 (or about 25% of the total DOC budget). Although telecommunications is an important application of satellites, it is by no means the only application. A number of satellites for other applications which are under study by the Space Sector and other departments concerned have been mentioned on page 11. It is interesting to note that the government is by far the largest customer for satellites in Canada (the only exception being the minority shareholders of Telesat Canada), so that there is a direct parallel which can be drawn between Bell Telephone funding of R&D at Bell Northern Research, and federal government funding of space R&D.

(c) CRC in an NRC-like Status

The transfer of CRC to NRC or the formation of an NRC-like body provides a sort of half way house between maintenance of the status quo and creation of a not-for-profit institute. It has the advantage of keeping the activities more closely tied to the federal government than would be the case if an institute were created, but this very fact is likely to make it harder to attract outside business. Personnel could more easily maintain pension rights and other benefits, but some of the difficulties of managing scientists under existing control mechanisms would remain.

Informal comments on the first draft of this report circulated within the department revealed a surprisingly strong sentiment in favour of the detachment of CRC from DOC. The writer himself has not adequately studied the

matter to have a strong opinion, but it is recommended that the possibilities discussed above (and possibly others) be subjected to thorough study so that, when a decision is taken either way, personnel at CRC can set off with a clear understanding of where they are going and what is required of them, at least over the next five years or so.

In the writer's view, an appropriate method for conducting the recommended study would be for two or three persons to take three or four months to prepare a report. The persons involved should between them have the following experience and specialized knowledge:-

(i) experience as a senior scientist at CRC over a number of years,

(ii) familiarity with the organization of science in the government,

(iii) an understanding of the policy and regulatory activities of DOC,

(iv) an understanding of the behaviour of organizations.

An important part of the study activities should be devoted to assessing the experiences of research institutions in Canada, the U.S. and the U.K. (and possibly elsewhere), so that existing experience with various organizational options can be adequately assessed.

(C) The Need for an Applied Research Theme

Whether the department opts to have the desired research and development performed in house or externally (or in whatever combination of the two), most of the R&D activities need in general to be oriented about policy related themes (in much the same fashion as they are now). This conclusion follows from the assumption that R&D should be used as an instrument of policy as well as to provide the information needed to develop policy. The themes will vary over time as priorities and perspectives change, and at any given time the relative prominence of the themes will vary. In all cases though, the rate of variation should be relatively slow if the government is to expect a reasonable return on its investment. Whether a research team is assembled in house or in the private sector, it is unlikely that it will achieve full productivity before three years have elapsed, which suggests a minimum economic theme duration of four to five years. (Redirection within a given theme will generally be economic in a much shorter time frame). Each theme will normally have associated with it a number of specific problems or opportunities requiring attention. Because the themes are largely tied to policy or

regulatory problems, the emphasis of the activity taking place is likely to be on exploratory development, whether this is in the form of systems studies, pilot projects or device or system development.

This fact of life (insofar as the needs of DOC per se are concerned) raises the fundamental difficulty of the theme system. For applied research and oriented basic research (for definitions see Appendix IV) provide much of the basic nourishment upon which successful exploratory development work depends, while simultaneously providing DND and other departments with the sort of service they need and expect from CRC.

The difficulty of fitting applied and oriented basic research into the standard "themes" is illustrated by the following examples. In the operational plan for 1976-77, solid state device R&D has been assigned to "space", fibre optics R&D is categorized as "rural" and image communications R&D is classed as "urban". All of these classifications are somewhat, though not totally, arbitrary. The solid state devices being developed are likely to find many applications, of which space telecommunications is but one, likewise fibre optics systems seem almost certain to have a broad range of applications from shipborne and airborne systems, to large scale rural and urban telephone and CATV systems to providing replacements for long distance coaxial cables. Likewise image communications developments may be ideally suited for rural use, although their first applications are likely to be in urban areas.

There is no easy solution to this dilemma. The writer is convinced though that the existing method of force fitting activities to themes only breeds misunderstandings and sometimes outright mistrust, the scientist wondering why his research must be squeezed into an almost meaningless category and suspecting that people are playing politics with his project, while the administrators suspect the scientist of moving his project from theme to theme to adjust to the prevailing political wind!

The writer would suggest, therefore, that a separate theme be supported, entitled "Telecommunications Applied and Oriented Basic Research", into which activities such as those listed would be grouped. It should be funded on the basis of a fixed percentage of the total R&D budget. The current figure, which provides a reasonable starting point, is about 27% of the budget and 40% of the man years.

Projects might start off under this theme with a long range plan, which would probably be of four to five years duration, and involve relatively limited manpower. If the project leader wished to increase the size of his project over the planned size, he could do so only by obtaining

"contracts" from other theme activities to undertake exploratory development in areas relevant to that theme. With time, successful programs would become increasingly involved in exploratory development, and the applied research base would wither away or move off into another promising area (according to long range plans), and the cycle could start again. The fibre optics research activity at CRC is following a route similar to that described, although, since an applied research theme which more accurately describes the work is lacking, it has been labelled a "rural" activity. (In fact both applied research and rural oriented development are being undertaken on the fibre optics project.)

The proposed theme has the advantage of providing some stability (if the percentage can be maintained) for the research activities which provide the basic nourishment to a healthy and productive research centre, but it would require wisdom and foresight to administer in the face of the normal dynamics of a bureaucracy, which will always try to redefine any source of funds to fit immediate requirements.

4. RESEARCH AND DEVELOPMENT THEMES

In the previous section the concept of R&D themes was discussed. In this section a set of R&D themes based on the R&D objectives set out in section 2 is suggested.

It would be nice to have a set of themes which were mutually orthogonal, in the sense that every project could be related to one theme and one theme only. In practice this objective is probably unachievable. The desire for orthogonality is, in any case, only a bureaucratic convenience to promote clarity and avoid argument. The set of themes proposed will doubtless be modified somewhat through further discussion (they have already been modified substantially as a result of discussion of previous drafts of this report). The writer believes however that the themes proposed represent a substantial improvement over the existing set of R&D objectives used in the project approval process in that there is less overlap and room for misunderstanding than currently exists.

The proposed themes are as follows:-

Theme 1 - Policy Development Studies

The development of policy frequently requires policy research and supporting systems research. Theme 1 R&D is thus the activity which, theoretically at least, gives birth to the basic policies of which R&D is but one of the means of implememmtation (regulatory action, negotiation and legislation being others). As already mentioned, policy research in communications often calls for supporting systems research, although all systems research is not necessarily in support of policy research. An in-house capability to carry out Theme 1 R&D is judged to be essential, although it should be accompanied by the contracting out of studies where possible.

Most policy development studies quite naturally are undertaken in the policy sector of the department. However this theme is relevant to other sectors where support (often in the form of background studies) is provided to the policy sector. Included under this theme would be the development of engineering/economic models and investigations of data transmission protocols. At this stage, the Rural Communication project falls primarily into this category, although there is an element of theme 3 involved.

An important general area for research under this theme which, in the writer's view requires greater attention than it currently receives, is the effect of communications on the social fabric. Because of the enormous difficulty of the subject, most efforts have been devoted to nibbling at the edges - either by studying the effects of new services

on minorities, or, by such studies as the effects of TV violence on violence in society. Important though these efforts are, they are but isolated aspects of the more general problem. It has been suggested that in fifty years time, today's telecommunications and broadcasting services will be seen to have had as great or greater influence on our society, as the automobile has had on cities. Our challenge then is analogous to that of the planners of the first quarter of the century who (rather unsuccessfully) tried to forecast the major impacts of the automobile industry. In the writer's view, research in this difficult subject should focus on identifying the cohesive and disintegrative influences of telecommunications and broadcasting on Canadian society as a whole. Thusfar, several aspects of the problem, including TV violence and the importance of a Canadian programming capability, have been picked out for special attention. A more general approach is, to the writer's knowledge, wanting.

It seems likely that much of such research could and should be undertaken on a contractual basis, possibly in direct cooperation with provincial governments at one or more universities or special institutes. The writer is clearly no expert, but he would like to see further debate and discussion of ways of encouraging this aspect of policy development studies.

Theme 2 - Support of Regulatory Activities

This theme, which is concerned primarily with spectrum management, but which may in future include small tasks related to attachment regulations, needs little explanation. Accelerating usage of the radio spectrum by a variety of interests leads to a need by the spectrum allocators and assigners (i.e. DOC) as well as by the users for a greater understanding of ways to utilize the spectrum better. Much (but by no means all) of the needed research related to this theme is in the area of radio propagation. Propagation research in particular should probably continue to be performed primarily in-house (i.e. at CRC) for the following reasons:-

(a) Since the activity the research supports is primarily regulatory in nature it is important that the bulk of the work be performed by a disinterested party.

(b) The sort of research performed is unlikely to lead to the development of new products - a prime motivation for directing research outside.

(c) For largely historical reasons the propagation research expertise at CRC is of particularly high calibre and international renown. It would be very difficult to rebuild an equivalent expertise in the private sector - especially in the light of (b).

(d) Some of the propagation work is of a classified nature in support of DND, and should therefore probably remain somewhere in government.

Theme 3 - R&D as a Policy Instrument

In Section 2, considerable space was devoted to the argument that R&D can be thought of as a policy instrument to be used by the department to help achieve its policy objectives (through support and encouragement).

Reference was specifically made to the departmental sub-objective to "... foster, develop and introduce new communications systems, facilities and resources."

The actual activities which will fall under this theme at any one time will, of course vary with the policy thrust of the department. Activities currently in progress (which might almost be called sub-themes) are:-

Remote Communications - primarily space related but includes some VHF and HF communications R&D (Trail radio and integrated remote communications systems).

Computer Communications - these activities follow on from the Green paper on this subject. At the present time they consist primarily of image communications R&D and activities to support the development of special applications of computer communications such as the P.E.I. medical project.

Insofar as some of the R&D undertaken under theme 2 is aimed at encouraging users to make more effective use of the radio spectrum, there is some overlap between these two themes.

Theme 4 - Space

R&D under theme 4 could, in principle, be apportioned out over several of the other themes (most notably themes 3 and 6), however, because of the magnitude and rather unique nature of Space R&D, it is sensible to leave it as a separate theme.

The writer has been provided with the following list of proposed sub-themes of the Space R&D program:-

i) Space Communications Applications Program (Major)

Those projects which use the unique capabilities of communications from space to serve various private and public needs (e.g., SCOPO, UHF, TELESAT 12/14).

ii) Space Technology Applications Program (Major)

Those projects whose main purpose is the direct application of space technology to other communication systems (e.g., RMS, SARSAT, SURVEILLANCE SATELLITE).

iii) Cooperative Program (Minor)

Those projects whose main purpose is co-operation with another agency or government (e.g., Symphonie, ARIANE, Space Shuttle).

iv) Technology Development Program (Minor)

Those projects devoted principally to the advancement of basic space technology and the maintenance of scientific expertise at the Field Centre.

v) Industry Transfer Program (Minor)

Those projects whose primary objective is the transfer of an identified technology to industry for the overall benefit of the Canadian commercial sector.

Theme 5 - Applied and Oriented Basic Research

This theme has already been discussed in more detail on pages 26-28.

Theme 6 - Research and Development Undertaken for Other Departments and Agencies

This theme has already been discussed on pages 16-18. It is only relevant as a theme if DOC continues to operate CRC as a part of the department (i.e. opts for the status quo). In this respect it differs from the other themes (with the partial exception of theme 4) where, were the department to be divested of CRC, these themes might well remain, with the major change being in the ratio of in-house to contracted R&D devoted to them.

5. MAKE OR BUY POLICY

A remarkable feature of DOC R&D (which shows clearly in Table VII of Appendix III) is that almost half the R&D expenditures in 1974 were on contracts to industry. This record is bettered only by IT&C and CIDA, both for the obvious reason that they have no internal need for R&D, but merely act as sponsors. The Medical Research Council, NRC and NH&W on the other hand spend heavily at Canadian universities and non-profit institutions. Of the departments most nearly comparable to DOC in terms of the relationship of R&D to their objectives, the following are the percentages of "scientific"* expenditures spent internally:- Environment (94%), National Defence (86%), Agriculture (99%), EMR (90%), and DOC (51%). Due to the end of the CTS project (a very large proportion of which was contracted out), the percentage of in-house scientific expenditures increased in 1975-76 from 51% to 63%. Comparative figures with other departments are not readily available. It seems most unlikely however that other comparable departments have yet come close to the DOC record in this regard.

It would appear that CRC (and its predecessor DRTE), have been directly responsible for the development of a number of commercially successful devices and systems, and have contributed to many others. As one who has had industrial R&D experience in Canada, the writer is firmly convinced of the greater effectiveness (in general) of government R&D contracts aimed at satisfying established needs (as exemplified by the Make or Buy Policy itself and the DSS Bridging Fund) over general grants aimed at meeting a predicted need (as exemplified by PAIT), although both activities doubtless have their place.

Most of the themes discussed lead to exploratory development activity, and it is precisely this sort of work which is most amenable to outside contracting.

Applied research and oriented basic research are more easily justifiable at a government laboratory than exploratory development. It is notoriously difficult to persuade small to medium sized industries to engage in such activities even with generous government assistance plans. The reasons are simple. Risks of such research leading to a satisfactory product are relatively high at the applied research stage, and much of the information needed will become available in the open literature. Smaller

*The category "scientific expenditures" is almost synonymous with "R&D expenditures" for most departments (including DOC), but excepting EMR and DOE for which it is 53% and 44% respectively. It does however include such activities as data collection, scientific information, testing and standardization, feasibility studies and scholarship programs.

companies have a relatively narrow base over which to spread such risks. Thus, although Bell Northern Research is well able to (and does) undertake some such research, the rest of the Canadian communications industry is, by and large, unable to assemble a critical mass of the requisite talent. In some instances the universities will perform oriented basic or applied research, although the usual preference is for free basic research. University researchers can be encouraged to undertake applied research contracts through a contracting process, but this still requires the existence either of resident expertise within DOC or of a professional research panel in order to manage such contracts.

The fibre optics program at CRC is a good example of the general category of applied research. In this case, BNR very quickly evinced a parallel interest and also set up a research group. Canada Wire and Cable which do not have facilities comparable to BNR, have looked to DOC (and I.T.&C.) for assistance, as has DND.

6. MEASURING EFFECTIVENESS

The measurement of R&D effectiveness is notoriously difficult but is nonetheless important both to researchers and to administrators, for it provides ultimately the basis upon which decisions for increased or decreased funding are made.

For theme 1 activity, (policy research and the systems studies which support it) the relevant criterion is quite simple. Did the work make a significant contribution to the formulation of "good" policy? Clearly the criterion is not scientifically objective. For a variety of reasons, highly relevant and potentially valuable systems studies can be totally ignored when policy is formulated. Just as clearly though, the study is as useless in this situation as if it had not been done at all, and has thus been a failure by this all important criterion.

Themes 2 to 6 are primarily exploratory developmental in nature and should have fairly well defined general goals as well as specific objectives. For example, under the radio spectrum utilization theme, workers might point to specific developments leading to spectral decongestion and the utilization and possibly even the economic operation of radio propagation prediction services. Of course, specific estimates of cost savings (or jobs created in industry) as a result of the work will often be hard to make, but even the attempt to find measures is usually an educational process.

The same is true of work in other themes. Do specific systems and devices developed result in the development of successful new products? Have the activities under the theme contributed materially to the furtherance of its overall objective? Are there better ways of furthering these objectives? These and other measures need to be refined early in program development, and the program should be reviewed against them as work progresses.

Applied research and oriented basic research will normally make greater use of such traditional research measures as peer group evaluation and the quantity and quality of publications, but if and as such projects expand towards exploratory development work, then the measures referred to in the previous paragraph will start to become relevant. Indeed, a significant measure of the success of the applied research work is the extent to which it leads to exploratory development activity (often accompanied by the registering of patents).

7. AFTERTHOUGHTS

This paper has benefited greatly from numerous helpful comments and criticisms by a number of people in DOC. In most cases where the writer was wise enough to heed the advice offered, appropriate changes were made in the text. There were however some matters raised which were not easily insertable at a late date, and these are mentioned below.

(A) The impact of possible membership in the European Space Agency (E.S.A.)

Several people asked the writer if he had considered what the implications would be for CRC were Canada to become a member of ESA. The writer's frank answer was "no", since he had not even been aware that membership in ESA was even a possibility. Should the government decide to join ESA however, it is clear that CRC would be affected, the extent of the effect being dependent on negotiations with ESA in the short term, and on the extent of Canadian participation in ESA programs in the longer term. In short, possible ESA membership is just another factor to be weighed in the thorough examination of institutional options for CRC which the writer has recommended.

(B) The Mission of the U.S. Office of Telecommunications

It seems unlikely that discussion of the role of CRC will terminate in the immediate future. It may assist further discussion to be aware of the stated mission of the Office of Telecommunications in the U.S. It is interesting to note that this organization forms a part of the Department of Commerce and hence has a strong orientation towards the promotion of economic growth.

> The mission of the Office of Telecommunications in the Department of Commerce is to assist the Department in fostering, serving, and promoting the nation's economic development and technological advancement by improving man's comprehension of telecommunication science and by assuring effective use and growth of the nation's telecommunication resources.
>
> In carrying out this mission, the Office
>
> - Performs analysis, engineering and related administrative functions responsive to the needs of the Director of the Office of Telecommunications Policy, Executive Office of the President, in the performance of his responsibilities for the management of the radio spectrum

- Conducts research needed in the evaluation and development of telecommunication policy as required by the Office of Telecommunications Policy, pursuant to Executive Order 11556

- Conducts research needed in the evaluation and development of other policy as required by the Department of Commerce

- Assists other government agencies in the use of telecommunications

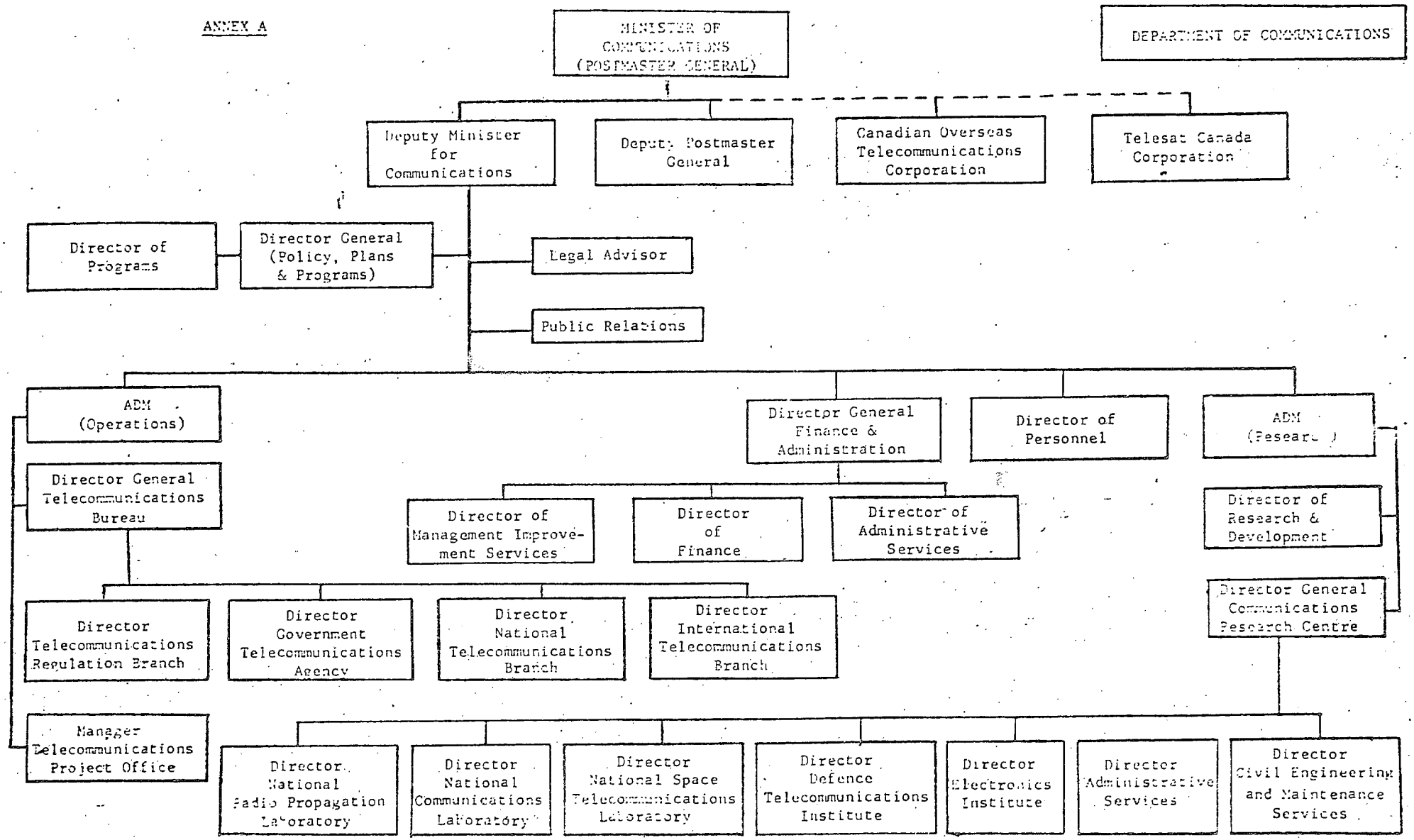
- Conducts research, engineering, and analysis in the general field of telecommunication science to meet government needs

- Acquires, analyses, synthesizes, and disseminates information for the efficient use of the nation's telecommunication resources.

(C) Memorabilia

A brief look at old organization charts is sometimes instructive as to concepts and plans of senior management in the past. The attached organization chart, which must have been one of the first for the new department, is illustrative of plans for CRC as a series of "national laboratories".

ANNEX A



July 9, 1969.

APPENDICES

CHAPTER C-24

An Act respecting the Department of Communications

Short title

1. This Act may be cited as the *Department of Communications Act.*

Department established

2. (1) There shall be a department of the Government of Canada called the Department of Communications over which the Minister of Communications appointed by commission under the Great Seal shall preside.

Minister

(2) The Minister of Communications holds office during pleasure and has the management and direction of the Department of Communications. 1968-69, c. 28, s. 7.

Deputy Minister

3. The Governor in Council may appoint an officer called the Deputy Minister of Communications to be the deputy head of the Department of Communications and to hold office during pleasure. 1968-69, c. 28, s. 8.

Duties of Minister

4. The duties, powers and functions of the Minister of Communications extend to and include all matters over which the Parliament of Canada has jurisdiction, not by law assigned to any other department, branch or agency of the Government of Canada, relating to

(*a*) telecommunications; and

(*b*) the development and utilization generally of communication undertakings, facilities, systems and services for Canada. 1968-69, c. 28, s. 9.

Further duties

5. (1) The Minister of Communications, in exercising his powers and carrying out his duties and functions under section 4, shall

CHAPITRE C-24

Loi concernant le ministère des Communications

Titre abrégé

1. La présente loi peut être citée sous le titre: *Loi sur le ministère des Communications.*

Création du ministère

2. (1) Est établi un ministère du gouvernement du Canada, appelé ministère des Communications, ayant à sa tête le ministre des Communications nommé par commission sous le grand sceau.

Ministre

(2) Le ministre des Communications occupe sa charge à titre amovible; il a la gestion et la direction du ministère des Communications. 1968-69, c. 28, art. 7.

Sous-ministre

3. Le gouverneur en conseil peut nommer un fonctionnaire, appelé sous-ministre des Communications, qui est le sous-chef du ministère des Communications et qui occupe sa charge à titre amovible. 1968-69, c. 28, art. 8.

Fonctions du Ministre

4. Les fonctions et pouvoirs du ministre des Communications englobent toutes les questions qui sont du ressort du Parlement du Canada et que les lois n'attribuent pas à quelque autre ministère, département, direction ou organisme du gouvernement du Canada, concernant

a) les télécommunications; et

b) la mise au point, le développement et l'utilisation, en général, d'entreprises, installations, systèmes et services de communications pour le Canada. 1968-69, c. 28, art. 9.

Fonctions supplémentaires

5. (1) Le ministre des Communications, dans l'exercice de ses pouvoirs et fonctions en vertu de l'article 4, doit

(*a*) coordinate, promote and recommend national policies and programs with respect to communication services for Canada, including the Canada Post Office;

(*b*) promote the establishment, development and efficiency of communication systems and facilities for Canada;

(*c*) assist Canadian communication systems and facilities to adjust to changing domestic and international conditions;

(*d*) plan and coordinate telecommunication services for departments, branches and agencies of the Government of Canada;

(*e*) compile and keep up to date detailed information in respect of communication systems and facilities and of trends and developments in Canada and abroad relating to communication matters; and

(*f*) take such action as may be necessary to secure, by international regulation or otherwise, the rights of Canada in communication matters.

a) coordonner, favoriser et recommander des politiques nationales et des programmes nationaux relatifs aux services de communications pour le Canada, y compris les postes canadiennes;

b) favoriser l'établissement, la mise au point, le développement et l'efficacité de systèmes et installations de communications pour le Canada;

c) faciliter l'adaptation des systèmes et installations de communications du Canada à l'évolution des conditions sur le plan intérieur et le plan international;

d) planifier et coordonner les services de télécommunications pour les ministères, départements, directions et organismes du gouvernement du Canada;

e) compiler et tenir à jour des renseignements détaillés sur les systèmes et installations de communications et l'activité dans le domaine des communications et sur les tendances et les progrès, au Canada et à l'étranger, dans ce domaine; et

f) prendre les mesures qui peuvent être nécessaires en vue de garantir, par réglementation internationale ou autrement, les droits du Canada dans le domaine des communications.

Agreements

(2) The Minister of Communications may, with the approval of the Governor in Council, enter into agreements with the government of any province or any agency thereof respecting the carrying out of programs for which the Minister is responsible. 1968-69, c. 28, s. 10.

Accords

(2) Le ministre des Communications peut, avec l'approbation du gouverneur en conseil, conclure des accords avec le gouvernement de toute province ou avec un organisme d'un tel gouvernement en ce qui concerne la réalisation des programmes qui relèvent de sa compétence. 1968-69, c. 28, art. 10.

Annual report

6. The Minister of Communications shall, on or before the 31st day of January next following the end of each fiscal year or, if Parliament is not then sitting, on any of the first five days next thereafter that Parliament is sitting, submit to Parliament a report showing the operations of the Department of Communications for that fiscal year. 1968-69, c. 28, s. 11.

Rapport annuel

6. Le ministre des Communications doit, après la fin de chaque année financière et au plus tard le 31 janvier suivant ou, si le Parlement n'est pas alors en session, l'un des cinq premiers jours où il siège par la suite, présenter au Parlement un rapport exposant l'activité du ministère des Communications au cours de cette année financière. 1968-69, c. 28, art. 11.

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OTTAWA, 1970

APPENDIX II

THE OBJECTIVES OF THE DEPARTMENT

The objective of the Department as set out in the Blue Book is "TO FOSTER THE ORDERLY DEVELOPMENT AND OPERATION OF COMMUNICATIONS FOR CANADA IN THE DOMESTIC AND INTERNATIONAL SPHERES". The objective has been broken down into four sub-objectives namely:-

a) To foster, develop and introduce new communication systems, facilities and resources.

b) To foster, develop and extend telecommunications services to obtain optimum benefits for Canada in the short and long term.

c) To protect and sustain Canadian interests in international telecommunications systems, services and undertakings.

d) To improve and extend the utilization of the radio frequency spectrum to permit the development and growth of radio communications.

Both the objective itself and the four sub-objectives leave much room for interpretation as to the amount of research which is appropriate. To this list of objectives should perhaps be added some other government objectives which influence the actions of the department as a whole (including the research sectors) to a greater or lesser extent. These include:-

e) To discourage further population concentration in the major urban areas.

f) To encourage government decentralization.

g) To promote bilingualism in Canada and in the public service.

h) "To improve the performance and the internal competitive position of Canadian industry". (Sub-objective (i) of the Department of Industry, Trade and Commerce).

i) To encourage contracting of government R&D as a substitute for in-house research (The Make or Buy Policy).

These last five objectives are by no means a comprehensive list, but rather are government objectives which come to mind as ones which influence or could

influence research at DOC. They are of course all the "prime responsibilities" of other departments, and it is a matter of both judgement and negotiation as to the extent to which DOC should itself commit resources to achieve such objectives. It is the writer's view that these "external" objectives act as secondary objectives whose effect is to influence the direction of research whose primary objective is broadly defined by one or more of the four departmental sub-objectives.

Finally, not mentioned in the objective or sub-objectives of the department is the understanding which was reached when the Department of Communications inherited the Communications Research Centre from the Department of National Defence in 1969, namely that the Communications Research Centre would continue to fund, on its own initiative, certain research of interest to the military as well as to other government departments, and that there would be direct DND funding in support of specific development projects. (Ref. the exchange of letters between Messrs. Kierans and Cadieux of January 9 & 10, 1969 included as Appendix IV).

APPENDIX III

SOME STATISTICS

It will be useful for the discussion of research in the second section of the report, to have some statistics available. Those presented in this section are by no means a complete selection, but rather represent the usual compromise between what is available and what is wanted.

(A) DOC Expenditures

In Table I the official allocation of resources, as it appears in the budget for 1975-76 is presented. For the purpose of discussion of R&D activities, these data have been reformulated and broken down in tables II and III.

As between tables I and II the following major changes have been made:-

1) The Government Telecommunications Agency, which, because it is financed as a revolving fund, appears separately in the Blue Book, has been included in table II, since it is, after all, a part of DOC.

2) The administrative allocation to R&D has been added into the general heading of departmental administration in table II, while it is included under Research in the Blue Book. This was done in an effort to clarify comparisons of manpower in various sectors, it does not imply of course that administration is not part of the cost of doing research. A factor which is not clearly brought out by either table is that the R&D administration figures include the maintenance of the research centre. Maintenance and rental of accommodation at headquarters is of course not included in either table.

3) In Table II there is a more detailed break out of activities particularly insofar as R&D is concerned. There is inevitably a certain amount of arbitrariness involved in allocation of resources to different categories. It is hoped that the footnotes will adequately clarify the assumptions made.

The following conclusions from Table II are worth noting:-

(a) About 53% of the man years and 44% of the budget are devoted to operations. Of these percentages,

TABLE I

DOC EXPENDITURES 1975-76

(As extracted from the Official Estimates 1975-76)

	Man Years	%	Total $	%
Administration	254	13.5	8,091,000	12.0
National Telecommunications Development & International Participation	138	7.3	5,252,000	7.8
Management of the Radio Frequency Spectrum	922	49.1	15,931,000	23.7
Contribution to Employee Benefit Plans	-	-	2,533,000	3.8
Research	565	30.1	35,396,000	52.7
Space Applications	(287)	(15.3)	(24,838,000)	(37.0)
Telecommunications	(278)	(14.8)	(10,558,000)	(15.7)
Total Expenditures	1879	100	67,203,000	100
Less Revenues			11,781,000	
Total Estimates			55,422,000	

TABLE II

DOC EXPENDITURES BY FUNCTION (1975-76 Operational Plan)

	MY	%	Total $(000)	%
Operations - Telecomm. Resp.[1]	919	44.7	15,846	17.4
GTA[2]	170	8.3	23,790	26.1
Total (Operations)	1,089	53.0	36,636	43.5
Policy Formulation[3]	173.9	8.5	9,094	10.0
Research and Development				
Space[4]	200	9.7	22,276	24.5
Other (excl. DND)[5]	136.2	6.6	5,737	6.3
DND[6]	70.6	3.4	1,203	1.3
Total (R&D)	407	19.8	29,216	32.1
Administration[7]	384	18.7	13,122	14.4
Total Expenditures	2,054	100	91,068	100

1. Includes Regional Offices and Telecommunications Regulatory Service.
2. Includes operations (88.9% by $ and 13.5% by MY) and administration of GTA.
3. Includes DM group, Comp/Comm Secretariat, NTB, ITB, FPRB, SPPB, EPS branches, $324K from University contracts and 5% of research services ($111K and 3.8MY).
4. Includes Technology, Programs and Applications branches, $106K from University Contracts, and 65% of Res. Services ($1448K and 50 MY).
5. Includes Policy and Planning, Systems and Technology, Radio and Radar, Education Technology branches (5MY), research relevant to Remote, Urban and Rural communications and management of radio spectrum, research services (16.2 MY and $556K) and University Contracts ($269K).
6. Includes research performed in the Space Sector (9.5MY and $129K) and the Research Sector (40.6MY and $829K) and supporting research services (6.8 MY and $112K).
7. Includes bilingualism, legal, personnel, financial, admin., information, security, management and computer services and maintenance of CRC (but not Headquarters or regional office rental and/or maintenance).

Note on Methodology: Research management (defined as expenditures of director and director general) has been prorated over space, telecommunications and DND program for each branch. Similarly research services have been prorated over Space (65%), Research (20%), DND (10%), and Administration (5%).

a relatively small fraction of the man years but a large percentage of the expenditures is devoted to GTA operations. GTA expenditures are, of course, reimbursable.

(b) Only 8.5% of the man years and 10% of the budget are devoted to Policy Formulation. Even this estimate is high, since much time and effort in the Policy Sector is, in fact, devoted to matters more closely related to operations (answering official correpondence and enquiries, responding to emergencies etc.) than in policy formulation in its more generally accepted sense. On the other hand, there are activities in both the space and the research sectors which fall into the category "systems engineering and policy research" which are supportive to policy formulation, and might be categorized under this heading. If these activities were included the total would be raised to about 10.5% of the man years and about 12% of the budget.

(c) Total R&D activities (including space and DND) account for 32% of the budget and almost 20% of the man years. To no one's surprise, space research and development accounts for the lion's share (over 75% of the total R&D budget and 50% of the R&D man years) of the R&D activities of the department.

(d) Of the non space man years devoted to R&D (about 10% of the total DOC allotment), almost one third are involved in fully reimbursable research for DND, the remainder being involved, in "non-space, non-DND research". It should be noted that the Research Services directorate which provides a variety of services largely to the Space and Research Sectors (including computer, machine shop, library, publications) has been prorated over the activities it supports.

(e) The remaining departmental resources are devoted to Administration - 18.7% of the man years and 14.4% of the budget. Administrative services include bilingualism, legal, personnel, financial, administrative, information, security, management and computer services (but not the running of the computer itself which is part of research services). As already mentioned, it includes all costs associated with accommodation at CRC, but not the accommodation cost at headquarters or in the regions.

In Table III an attempt has been made to break out the research activities according to the basic categories of research previously described. It can be seen from the table that basic research activities are virtually non-existent in DOC, the small item of expenditure included being for small contracts under the University Research Program.

The greatest proportion of research expenditures falls into either the applied research (40% of man years, 27% of expenditures) or the exploratory development (50% of man years, 67% of expenditures) categories. Here the emphasis is entirely different as between space and other telecommunications R&D, with about 80% of the space effort being devoted to exploratory development while only about 15% of other telecommunications R&D falls into this category. This apparent imbalance reflects the special role of the space program as a development agency, a role which is largely filled by the communications industry and the common carriers insofar as non-space telecommunications is concerned. A relatively high percentage of the effort devoted to applied research in the telecommunications segment is propagation research. The special status of this work is discussed in section 4 of the main text.

Table IV shows the official departmental return to Statistics Canada on the distribution of expenditures on scientific activities. The writer was unaware of the existence of these figures when he initiated the work which led to the compilation of the figures in Table III. It is gratifying to note that the figures correspond quite well except that the estimates of oriented basic research are respectively 0.2% in Table III and 3% in Table IV. Since it is difficult to classify accurately work which falls at the boundaries of definitions, this discrepancy is not considered to be serious.

It will be noted that whereas Table III indicates that Space R&D accounts for 76.3% of DOC R&D expenditures, Table IV indicates a figure of only 67%. This is because the figures in Table III have the administrative burden totally removed and the research services burden prorated, whereas in Table IV the total research services budget appears as "Research", and the administrative budget has apparently been apportioned other than according to relative expenditures in the two sectors. The great majority of R&D undertaken for DND appears as "Research" in Table IV but is broken out separately in Table III.

(B) Industry Statistics

In Table V an attempt has been made to determine total revenues from telecommunications in Canada. Some appreciation for the size of the sector is useful as one

TABLE III

DOC RESEARCH EXPENDITURES BY TYPE (1975/76)
(PRELIMINARY)

	SPACE		TELE COMMUNICATIONS		DND		TOTAL	
	MY, $	%	MY, $	%	MY, $	%	MY, $	%
BASIC RESEARCH	-	-	-	-	-	-	-	-
	-	-	51.5K	.2	-	-	51.5K	.2
APPLIED RESEARCH	39.8MY	9.8	82.7MY	20.3	42.6MY	10.5	165.1MY	40.5
	3917 K	13.4	3321 K	11.2	798 K	2.7	8036 K	27.1
EXPLORATORY DEVELOPMENT	156.6MY	38.5	17.9MY	4.4	28.0MY	6.9	2025 MY	50.8
	18,304 K	62.7	1079 K	3.7	405 K	1.4	19788 K	67.7
SYSTEMS AND POLICY RESEARCH	3.7MY	.9	35.6MY	8.7	-	-	39.3MY	9.7
	55 K	.2	1286 K	4.4	-	-	1341 K	4.6
TOTAL	200 MY	49.1	136.2MY	33.5	70.6MY	17.3	407 MY	100
	22,276 K	76.3	5737 K	19.6	1203 K	4.1	29216 K	100

1. Policy formulation has been included in Systems & Policy Research.

2. Senior officers in the Research & Space Sectors have been prorated over the projects they administer.

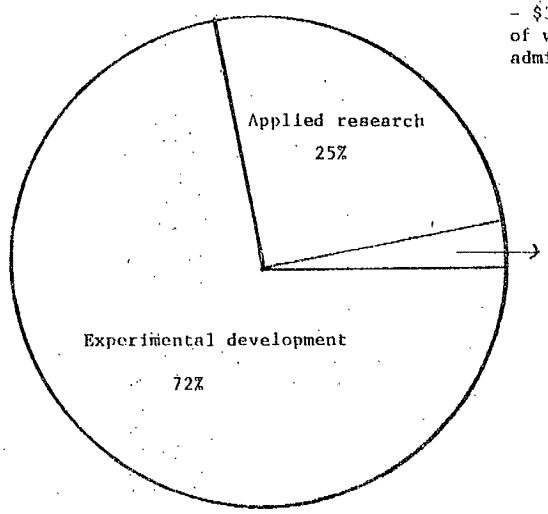
Note on Methodology: An attempt has been made to separate expenditures on research management at the directorate level and above from total expenditures in the research, space and DND programs. The non-management expenditures in each branch were divided into type of research and the research management expenditures were prorated over these expenditures by man year and fiscal expenditures. Similarly research services have been prorated over Space (65%), Research (20%), DND (10%), and 5% Administration. Expenditures on University Contracts were divided by type of research and added to the above figures.

TABLE IV

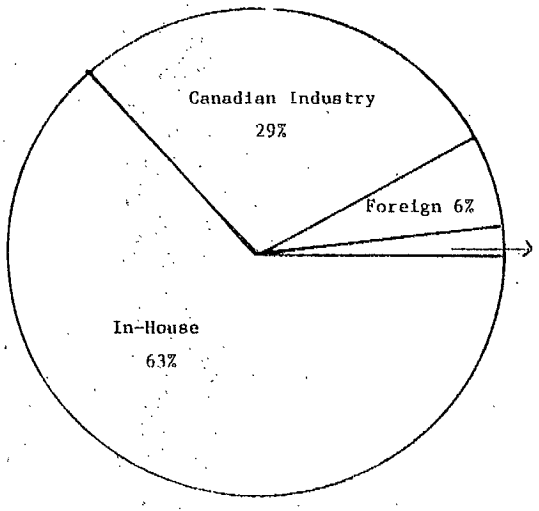
TOTAL DOC BUDGET IN SCIENTIFIC ACTIVITIES

75/76 $37,116,000*

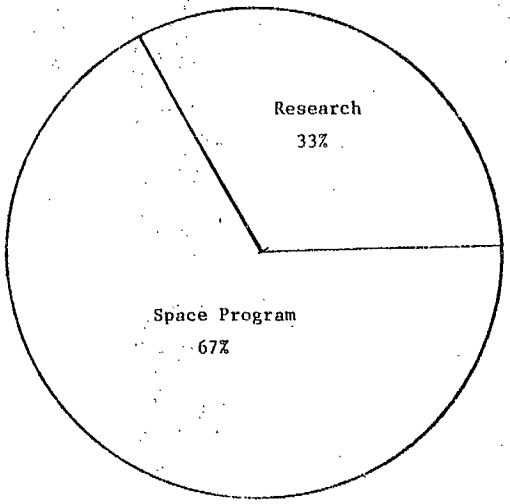
*Includes - $2,094,000 for human science activities,
- $35,022,000 for natural science activities,
of which $5,810,000 is for construction and administrative and other support services at CRC.



Fraction of in-house R&D by type of scientific activity



Fraction of scientific activities budget carried out in-house and by contracts



Relative fraction of scientific activities budget in Space Applications and Telecommunications Research

TABLE V

TELECOMMUNICATIONS REVENUES BY SECTOR
(1974 Unless Otherwise Indicated)

Common Carriers	Total Operating Revenues (millions of dollars)
Bell Canada[1,2]	$ 1,440
Other Major Telcos[1,3]	933
Others[4]	223
Total	$ 2,596
Broadcasting (1973)	
Operating Revenues[5]	331
CBC Subsidy[5]	221
Sub Total[5]	552
CATV Revenues[6]	107
Total	659
Total + 10% to adjust to 1974	725
Estimated Total Services[7]	$ 3,321
Manufacturing	
Northern Electric[8]	813
Other[9]	Unknown
	$ 1,000?
Total Contribution to Gross Domestic Product	~ $4.3 billion

NOTES TO TABLE V

1. Source - Financial Statistics on Canadian Telecommunication Common Carriers, 1974 (D.O.C. Report)

2. Not including revenue from subsidiaries included in note 3 below.

3. Includes AGT, B.C. Tel, Edmonton Tel, Manitoba Tel, Maritime Tel, N.B. Tel, Holland Tel, Northern Tel, Quebec Tel, and Sask. Tel.

4. Includes CNT ($102M), CPT ($49M), COTC ($44M), Telesat ($28M). Figures were not readily available for the independent telephone carriers, which would, in any case, have only a marginal effect on the totals.

5. Source - Radio and Television Broadcasting, 1973, Statistics Canada 56-204.

6. Source - Community Antenna Television, 1973, Statistics Canada 56-205

7. This compares well with the Gross Domestic Product estimate for communications in Table VI of $3,349K.

8. Source: Submission by Northern Electric Company Ltd. to the Royal Commission on Corporate Concentration. Total sales were $971M, but of this total $813 M were classified as Telecommunications Sales.

9. Amongst "Others" would be found the Canadian portions of Automatic Electric and Lenkurt Electric, part of RCA Canada revenues and a number of smaller companies. (see for example "Canadian Telecommunications Carriers and their Suppliers", DOC Working Paper, June 1974).

TABLE VI

GROSS DOMESTIC PRODUCT - 1974

Source - Statistics Canada

Factor at Cost	Millions of Dollars	%
1. Agriculture	$ 5,565	4.4
2. Forestry	1,089	0.9
3. Fishing	213	0.2
4. Mining	5,943	4.7
5. Manufacturing (incl. Comm. Equipment ~$1,000M)	28,493	22.7
6. Construction	8,531	6.8
7. Transportation	6,966	5.6
8. Storage	327	0.3
9. Communications of which Telecommunications & Broadcasting Newspapers & other	3,349	2.7
10. Utilities	3,701	3.0
11. Wholesale Trade	6,538	5.2
12. Retail Trade	8,473	6.8
13. Finance	13,619	10.9
14. Public Administration & Defence (~$2,200M)	8,941	7.1
15. Services	23,629	18.8
Total	$125,377	100%

indicator of the expenditures in R&D which might be appropriate. Official figures were hard to come by, and it can be seen that there has been some rough estimating.

In Table VI, the contributors to the Gross Domestic Product are listed. It will be noted that the communications share including the newspaper industry but excluding the communications manufacturing industry is 2.7% of the total GDP. Table V indicates a contribution to the GDP from the Telecommunications sector of $4.3 billion, or just over 3.4% of the GDP.

The common carriers and the broadcast and CATV industries had combined revenues of about $3.3 billion in 1974. The DOC budget alone (excluding GTA) is about 2% of these expenditures. To obtain some idea of the proportion of total public sector expenditures to control and cajole the private sector as a proportion of private sector expenditures, it would be necessary to add in the budgets of the CRTC, and appropriate segments of the budgets of provincial departments of communications.

R&D expenditures in industry are very difficult to estimate, although we do know that gross expenditures of Bell Northern Research were approximately $49M in 1974. In the DOC Brief to the Senate Special Committee on Science Policy (July, 1976) it is estimated that total industry expenditures in 1974 were in the neighbourhood of $120M. A very large proportion of these funds were devoted to development.

Some general rules of thumb regarding R&D expenditures in communications were provided in the Telecommission Study* 4(b) as follows:-

In the Communications Industry,

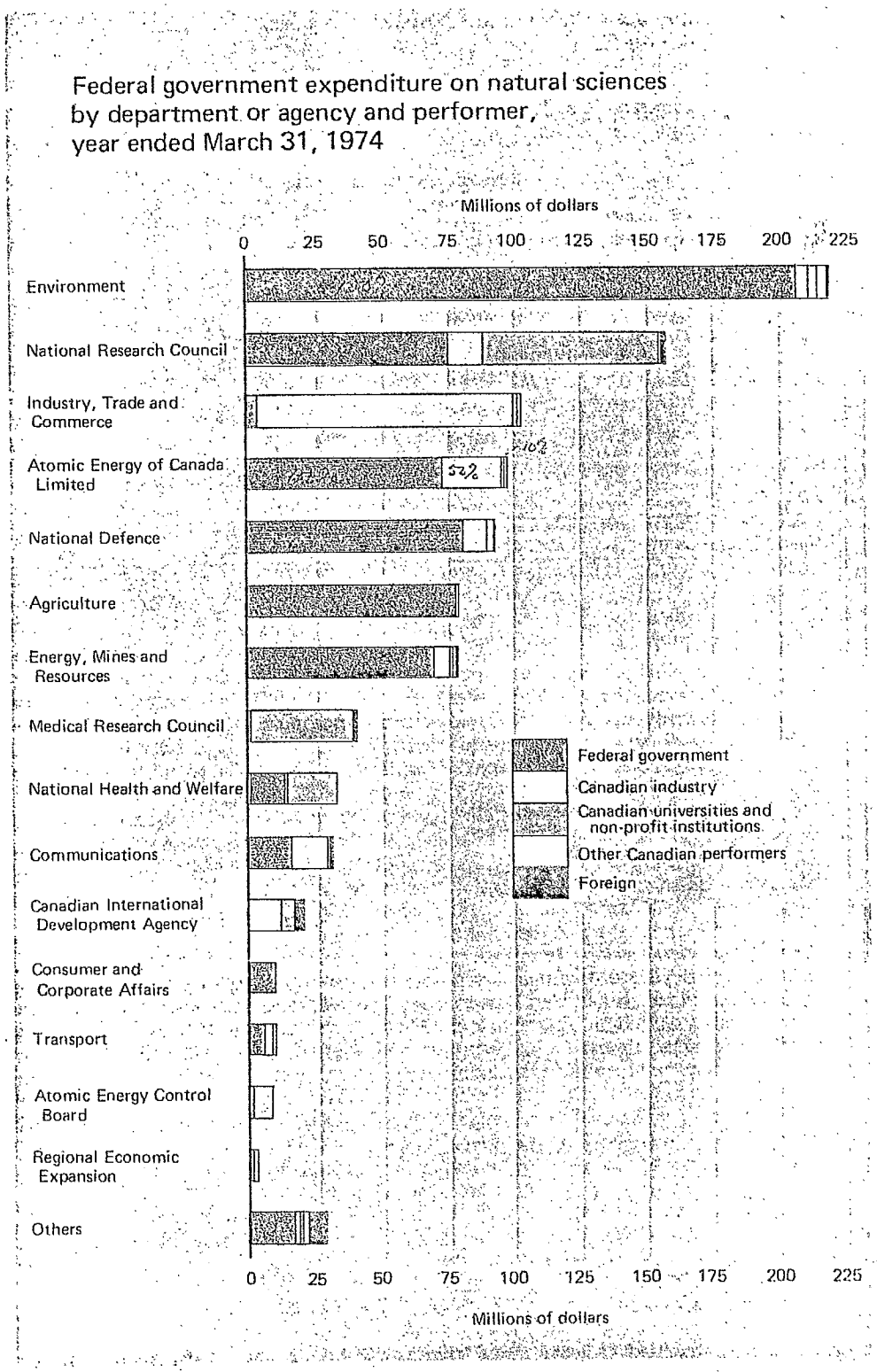
i) R&D costs range from 15% to 50% of total innovation (start-up) costs for new products.

ii) a) R&D costs range from 1% to 8% of probable sales of new products.

b) Total innovation costs range from 5% to 20% of the sales of new products.

*Research and Development Policies and Programs, Telecommunications Study 4(b). The quotation is from Appendix R "The Economics of Research and Development".

TABLE VII



Source: Canada Year Book 1974
page 346

iii) The decision to undertake or not to undertake a new product venture is based, in an increasing number of cases, on a methodology which ascribes values to the cost of R&D and the possible or potential pay-off from incurred R&D expense.

(C) Some Comparisons with Other Government Departments

Table VII, extracted from the Canada Year Book for 1974 shows the distribution of expenditures on natural sciences by department. DOC, with expenditures of $31.2M, accounted for just over 3% of the total. Excluded from the total however are IT&C and NRC communications related grants to industry and to the universities, as well as exploratory development under the aegis of the DSS Bridging Fund. Offsetting these exclusions however, is non-communications related space research, which is difficult to estimate accurately. Incidentally R&D accounts for approximately 75% of total "expenditure on the natural sciences", the remainder being devoted to such activities as data collection, testing and standardization, feasibility studies and scholarship programs. According to Statistics Canada about 98% of DOC expenditure on the natural sciences is devoted to R&D.

A remarkable feature of DOC R&D (which shows clearly in Table VII) is that almost half the R&D expenditures are on contracts to industry. This record is bettered only by IT&C and CIDA, both for obvious reasons. The Medical Research Council, NRC and NH&W on the other hand spend heavily at Canadian universities and non-profit institutions. Of the departments most nearly comparable to DOC in terms of the relationship of R&D to their objectives, the following are the percentages of scientific expenditures spent internally:- Environment (94%), National Defence (86%), Agriculture (99%), EMR (90%), DOC (51%), and MOT (63%). Due to the end of the CTS project (a very large percentage of which was contracted out), the percentage of in-house scientific expenditures increased in 1975-76 from 51% to 63%. Comparative figures with other departments are not readily available. It seems most unlikely however that other comparable departments have yet come close to the DOC record in this regard.

DOC does spend a very high proportion of its total budget on expenditures in the natural science (53% according to Table I, and still 32% when the adjustments made in Table II are taken into consideration.) By contrast, EMR appears to spend about 33%, Agriculture about 16% and Environment 69%. In the case of Environment though, a very high percentage of expenditures are for "Data Collection" and "Scientific Information". Thus only about 26% of DOE expenditures are on R&D <u>per se</u>.

The writer wishes to acknowledge the contribution of Maurice Estabrooks who compiled the data used in Tables II, III and V.

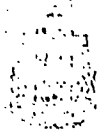
APPENDIX IV

CORRESPONDENCE REGARDING THE TRANSFER OF CRC FROM DND TO DOC

The attached letters constitute the formal agreement between DND and DOC regarding the research and development capabilities that DND has a right to expect to be available to it at the Communications Research Centre.

ADG

OFFICE OF THE POSTMASTER GENERAL



CANADA

CABINET DU MINISTRE DES POSTES

OTTAWA 8, ONT.

January 10, 1969

The Honourable L. Cadieux
Minister of National Defence
Ottawa, Ontario

My dear Colleague:

The various aspects of the transfer of the Defence Research Telecommunications Establishment from the Department of National Defence to the Department of Communications, including arrangements for various interim services to be provided by your department, have been examined by our respective staffs, and I am happy to accept your letter of 9th January, 1969, with its appendices, as an agreement to be put into operation immediately.

Yours sincerely,

Eric Kierans

~~Enc.~~

Received from CDRB. [illegible] 10/1/69

60.

MINISTER OF NATIONAL DEFENCE

CANADA

MINISTRE DE LA DÉFENSE NATIONALE

Ottawa 4, Ontario
9 January, 1969

The Honourable Eric Kierans, P.C., M.P.,
Postmaster General of Canada
Ottawa, Ontario

My dear Colleague:

Consequent upon your letter of 16 October, 1968, your Planning Staff and the staff of the Defence Research Board have met to arrange the orderly transfer of the Defence Research Telecommunications Establishment to the Department of Communications. Their recommendations are contained in the appendices to this letter and involve the following broad principles:

(a) Scientific Operations

The total program, including defence projects, will be agreed upon between the two departments with funding for the DND/DRB portion provided in the DND/DRB Estimates on a recoverable basis. A small DRB resident staff will be accommodated to provide necessary liaison in respect of defence projects. (Appendix A)

(b) Real Estate and Support Services

The entire Shirley Bay complex, including all inventory and stores, will be transferred to the Department of Communications, with the exception of the Defence Chemical, Biological and Radiation Establishment buildings, Bldg. No. 27, areas Nos. 5, 7 and 10. The Department of Communications will be responsible for all general and common site maintenance services. Services and supplies of a special nature, including minor construction, may be supplied by Department of Communications on a recoverable basis. The Department of Communications will continue to provide the present office accommodation to the field engineer of Defence Construction Limited at Shirley Bay while he provides service to the Department of Communications on the site. (Appendix B)

/2

(c) Support of DRB Extramural Program

On request the Telecommunications Establishment will provide advice and supervisory services for DRB extramural activities, as at present, subject to recovery of any special expenditure required. (Appendix C)

(d) Security

The present system and standards of security will be maintained. (Appendix D)

(e) Support Services to be provided by DND/DRB

There is a requirement for the Defence Research Board to continue the provision of support and general services to the operations at the Telecommunications Establishment until such time as the new Department of Communications comes into effective operation. The objective date is 1 April, 1969. It is recognized that services may be required for some additional months, but not after 1 July, 1969. (Appendix E)

(f) Personnel

The Defence Research Telecommunications Establishment manpower allocation will be transferred to the Department of Communications. It is understood that the administrative authority will be the Deputy Head, Post Office (Communications), but that continuing personnel administration by DRB will be required, according to its rules and procedures, until the DRTE staff can be transferred into classified positions. This extension of personnel services is not expected to be required after 1 July, 1969. The formal Resource Transfer document includes in Primary 01 the sum of $211,369 assessed as the DRTE share of the DRB funds set aside at the beginning of the fiscal year to meet 1968/69 salary revisions. Appendix E shows the continuing services to be provided by DRB and Appendix F contains details of the personnel transfer.

(g) Finance

The Estimates for the Department of Communications will reflect the entire cost of manning and operating the Telecommunications Establishment and the Shirley Bay site. The DRB share of telecommunication costs will be shown as

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recoverable and carried in the DRB Estimates. There will be, in addition, payment to the Department of Communications of costs of services required by DRB at the Shirley Bay site, mainly for support services to the Defence Chemical, Biological and Radiation Establishment. These costs are estimated in detail for 1969/70 in Annex I of Appendix B and will be covered by a transfer of funds by F.E. as required.

(h) Computer Service

Some computer service has been provided hitherto by DRTE to DRB Headquarters and the Department of Communications will endeavour to continue this service at the level now obtaining, i.e., up to 30 hours per month. It is, however, recognized that the limit of capacity of the existing machine, in two-shift operation, will be reached in early 1969 and that, if the projected new machine is not installed by mid-1969 this service will have to be renegotiated. Continuing computer service for DCBRE will be provided as outlined in Appendix B.

While the details of the appendices are concerned with the program for fiscal years 1968/69, 1969/70, and with the immediate problems of orderly transfer, it is understood that the broad principles stated above will provide a basis of understanding upon which the Chairman, Defence Research Board and the Deputy Minister, Department of Communications, will be able to resolve details of program and administration both for program review and as arising from time to time.

Your concurrence would be appreciated.

Yours sincerely,

ORIGINAL SIGNED BY
L. CADIEUX

AGREED ARRANGEMENTS FOR TRANSFER OF DRTE AND FOR CONTINUATION OF THE DEFENCE TELECOMMUNICATIONS RESEARCH PROGRAM

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PART I - DEFENCE TELECOMMUNICATIONS RESEARCH PROGRAM

Section I - General

1. DND/DRB Defence Projects

It is understood that the DND/DRB projects at present operating at the Defence Research Telecommunications Establishment (DRTE) will be continued to an agreed stage. A firm understanding exists between DND/DRB and DOC to initiate new defence oriented projects at DRTE approved by the Ministers of National Defence and Communications.

2. Consultation on the Research Program

While the principle of relying on a communications research program formulated and conducted by DOC is accepted, there is considerable concern in DND that the level of research related to defence matters may decline and the ability of DOC to supply the required consultation, assistance and innovation may also decline.

2.1 The formal opportunity for examination of the nature of the future research program by DRB will occur at the time of the Program Forecast preparation. It is therefore agreed that DRB be given the opportunity to examine the future program in depth at this stage.

2.2 To maintain the necessary defence climate, the following additional but less formal channels are recognized without diminishing in any way the overall authority of the Director-General:

(a) the presence of seconded military officers at DRTE.

(b) the DRB Telecommunications Liaison Office (TLO) at DREO as a source of defence background and as a focal point for international defence communications interests; and

(c) continued close working relations between DRTE staff and DND/DRB officers (military and civilian).

3. The TLO Office at DREO

The TLO at DRTE will be responsible to the DG/DREO as the formal channel of liaison between DND and DRTE. Its functions will be:

(a) the monitoring of projects within DRTE funded by DND/DRB;

(b) the coordination of DND/DRB projects with the relevant components of the DND organization;

(c) negotiations of small tasks funded by DND/DRB;

(d) the monitoring of the DRTE research program in order to inform appropriate components of DND of advances in science and technology related to defence telecommunications interests;

(e) to provide advice to the Chairman, DRB on telecommunications matters, and

(f) the initiation of new defence scientific projects jointly approved by Chairman, DRB and the Deputy Minister of Communications .

4. DND Interest in the Domestic Satellite Communications System

The DND interest in the domestic satellite program is expected to develop and the requirement for operational and technical consultation to increase. This will now be met by DOC (and presumably by the Satellite Corporation when formed) and DRTE will be brought into the matter as required.

5. Proposed Basis for Establishing, Costing and Supervising DND/DRB Projects in DOC and Vice Versa

Each such project will be formulated and cost estimates agreed in advance between the Deputy Chairman (Scientific), DRB and the A/DM (Research), DOC. The project will be included in the estimates for the originating department and payments will be by Financial Encumberance set up at the beginning of the project.

5.1 Requests may be raised by one department to the other at any time. Responsibility will be placed upon the officers responsible for Program Forecasts and Main Estimates to consult formally and define the interdepartmental projects.

5.2 Where only consultation services and specialist advice are provided, it will be without payment except for travel and allowances where appropriate.

5.3 There will be an assured DRTE effort available for small defence tasks in addition to defined projects as in first paragraph above.

5.4 When an interdepartmental project is established every facility will be granted to the requesting department to discuss and monitor progress.

6. Finance

The Estimates for the Department of Communications will reflect the entire cost of manning and operating DRTE and the Shirley Bay site. The DRB share of telecommunication costs will be shown as recoverable and carried in the DRB Estimates. There will be, in addition, payment to the Department of Communications of costs of services required by DRB at the Shirley Bay site, mainly for support services to the Defence Research Establishment Ottawa.

Section 2 - Disposition of Current Projects

7. General

The DOC has responsibility for planning and executing a communications research program adequate to the national need. It will not, therefore, ask other departments to support research programs at DRTE.

7.1 Tasks undertaken for other departments (and therefore paid for by other departments) will be definable as projects. For reasons of effective management and budgetting, splitting of projects between DOC and another department will be avoided.

8. Project Survey

All the current projects at DRTE have been reviewed and classified as:

Group 1 - projects remaining a DRB responsibility and therefore not transferred (all geophysics);

Group 2 - projects becoming the responsibility of DOC immediately on transfer and therefore subject to change or cancellation. The notes reflect DND interest;

Group 3 - projects funded by DND/DRB

(These projects are identified by their current DRB Project Coordination Centre number)

Group 1

95-11-55 - Effects of Time Rate of Strain on Clay Soils (McGill University CD 700002)

97-90-12 - Terrain Evaluation for Mobility (McGill University Contract CD 600002)

35-30-15 - Geophysical Studies in the High Arctic

Group 2

02-01-02 -	Flexible Body Dynamics	- No direct DND interest
02-04-02 -	ISIS	
95-11-34 -	Studies of the Ionosphere using Whistler Modes of Propagation	- Will provide basis for advice and assistance.
95-11-36 -	Synoptic Research on the Disturbed Ionosphere	
95-11-01 -	Theoretical Studies of Problems Related to the Ionosphere	
95-11-40 -	The Analysis of Radio Soundings of the Ionosphere from Satellites	
28-01-07 -	Radio Communication Research	- Will provide basis for advice and assistance. There will be a need to continue research in the frequencies of military as well as civil interest.
28-01-14 -	Application of Signal Processing to Telecommunication Techniques	
55-03-08 -	Microwave and Optical Properties of Materials	
28-01-19 -	Microwave Propagation	

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Group 2 (contd)

55-66-01 - Semi-Conductor Research (Circuits)	)	
55-66-11 - Growth Conditions, Junction Formation & Properties of Semi-Conductors	)	- Of general DND interest
55-68-08 - Advanced Circuit Design (New Project)		- This field is of vital DND interest and it is expected that there will be a rapid increase in the level of advice and assistance required by the Forces as the use of micro-electronics components increases. It is essential that DND have available an independent source of in-house government advice to assist in decision-making with regard to military electronic equipment.
28-04-10 - Automatic Techniques in Data Processing		- DND will continue to expect support on automatic data processing techniques concerning communications equipment, sonar signals, radar signals, etc, at about the same level as in the past.
28-60-05 - Multiple Access Satellite Communications		- This project is of vital concern to DND and it is essential that research be continued in the areas of specific military interest including the use of spread spectrum adaptive techniques in the presence of jamming.
28-30-13 - Studies of High Speed Communication Techniques		- This project was initiated in support of specific military needs and is well advanced. DND will expect that it be supported to completion.
38-03-61 - Detection System Studies		- The radar group recently set up in DRTE will be continued by DOC. A portion of this project will be separated and funded by DOC to support research related to civil radar interests.
95-11-33 - Studies of the Ionosphere using VLF/LF and HF Modes of Propagation	)	- These DOC programs produce information of special military interest.
97-52-01 - HF Radio Propagation Prediction Service	)	DOC will undertake not to change them materially without prior consultation with DRB.

Group 3

28-01-20 - Vulnerability of Spread Spectrum Communications	- Study contract managed by DRTE, which will be completed during 1968/69. An experimental program may be the subject of a later request for DRTE participation.
38-10-38 - HF/DF 28-30-16 - Improvements to RCN Communications 28-01-31 - Tactical Satellite Communication (New Project) 38-80-05 - Intercept and Analysis Techniques	)- Requirement papers provided by DRB as basis for cost estimates contained in Section 3.
38-03-62 - Tandem	- DRB estimates 3 DRTE scientific staff to be minimum support required for Phase II. Phase I due to be completed December 1968.
38-03-61 - Detection System Studies 38-80-05 - Intercept and Analysis Techniques	)- Before the end of the current fiscal year the portion of project 38-80-05 not covering ZANDER and the portion of project 38-03-61 concerned specifically with military radar will be consolidated into one new project to cover Military Radar and Electronic Warfare Research and Applications. The project will be funded by DRB at a level of $400,000 in 1969/70.

Section 3 - Summary of 1969/70 Costs for Interdepartmental Projects

Project	DRB Funds O & M $	DRB Funds Equipment $	CTS Funds $
9.			
DND Projects at DRTE			
28-30-16 - Tobacco	56,000	-	710,000
38-10-38 - HF/DF	286,000	57,000	150,000
28-01-31 - TacSatCom	222,000	22,000	100,000
38-80-05 - ZANDER	213,500	24,000	75,000
38-03-62 - Tandem	96,500	-	Note (a)
- - Military Radar and Electronic Warfare Research and Applications	350,000	50,000	Note (a)
Project for small tasks in communications and electronic warfare generally	415,000	80,000	Note (b)
	1,639,000	233,000	
DOC Project in DRB Batteries and Power Source Research	83,000	-	

Note (a) - not yet determined
Note (b) - small amounts as required

PART II - Transfer of DRTE

Section 1 - Funds

10. (a) On August 28, 1968, and January 16, 1969, by Minute 682645 and 685824 respectively, Treasury Board approved redistribution of financial resources with respect to the transfer of DRTE from DRB to DOC. For 1968-69 it involved transfer of a total of $10,549,276 from DRB ($5,978,354 from Vote 25, $1,070,000 from Vote 30 and $3,500,000 from Vote 40).

(b) Included was the sum of $211,369 assessed as the DRTE share of DRB funds set aside to meet 1968-69 salary revisions.

(c) The tentative DOC program allocation for 1969-70 assumes the sum of $2,294,000 to be included in the DRB Estimates for 1969-70 for program and services to be provided by DOC.

Section 2 - Manpower and Staff

11. The above-mentioned Treasury Board Minutes also approved transfer of 26 positions for DOC Headquarters and 460 positions representing the allocation for DRTE. Because the Revised Estimates for 1968-69 showed DRB having the same number of man-years as positions, it was necessary to transfer the same number of continuing man-years as positions (460) for purposes of arriving at the 1968-69 man-year figures to be printed in the 1969-70 Estimates. However, man-year employment against the 460 positions may not exceed 447 in 1968-69.

12. The total number and distribution of positions and man years transferred from DRB for DRTE were:

Total Positions:	460
Total man-years:	460 + 61 casuals

with distribution as follows:

Scientific and Professional	114
Administrative and Foreign Service	8
Technical	185
Administrative Support	72
Operational (Classified)	58
Operational (Prevailing Wage)	23
	460
Continuing Employment (Man-Years)	(460)
<u>Casuals</u>	
Part-time and Seasonal (Vote 25)	15
Maintenance (Vote 25)	33
Construction (Vote 30)	13
	61

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13. With a few exceptions, the members of the staff of DRTE were transferred to DOC. They are listed in Annex 1 to this Appendix "A". Excluded from the transfer were positions for and members of the DRTE staff employed in the Geophysics Group and the DIR Group who have been reallocated to DREO.

Section 3 - Real Estate (see also Para 16)

14. Lands

The various land parcels presently used by DRTE and DREO fall in different categories. The following dispositions are agreed upon:

(a) PARL This land parcel of approximately 1,000 acres is owned by the Province of Saskatchewan and leased to DRB at 50¢ an acre per annum. The same arrangement will continue under DOC while responsible for the operation of the site. Payment of the rental in advance was recently made by DRB, covering the period to June 30, 1969. Financial adjustment in this case may be required.

(b) Area #6 - Ashton, Ont. This land parcel of approximately 490 acres was purchased by DRB. It will be transferred from DND to DOC.

(c) Main Site - Shirley Bay This consists of areas #1, 2, 3, 4 and 8. The land parcel is approximately 837 acres and is occupied by DRTE, DREO and DRB/HQ (DSIS). It will be transferred from DND to DOC.

(d) Areas #10 and #7 - Connaught Range. This area of approximately 594 acres is used exclusively by DREO. It will continue to be controlled by DND and reserved for DRB use.

(e) Area #9 - HFDF Site, Stittsville. This land parcel of 150 acres was purchased by DND with funds provided by CFHQ in 1967. It will be transferred to DOC.

(f) Area #5 - Quiet Site - Connaught Range. This parcel of approximately 200 acres is presently used by DEMR and DRTE. DND is opposed to the transfer of this land to DOC but is, however, willing to work out suitable arrangements with DOC to allow use of the area under the control of DND. In other words, expansion of the utilities and facilities will require DND approval in each case.

15. Buildings

(a) DRTE Buildings. These include shared accommodation, e.g., cafeteria, garage, workshops, heating plant, where applicable, to be transferred and to be the full responsibility of DOC.

(b) DREO Buildings. The following DREO buildings as identified on the joint DRTE/DREO main site plan will be retained (including inventory and stores) by DRB, on the understanding that DOC will provide on a recoverable basis for the maintenance and minor construction requirements: Bldgs. Nos. 5A, 5B, 5C, 6, 9, 10, 17, 22, 24, 29, 29A, 36, 50, 58, T15. DREO will continue to have partial occupancy of Bldgs. Nos. 8, 35 and 55.

(c) DRB/HQ (DSIS) Bldg. No. 27. Will be retained by DRB and, for practical purposes, will be considered part of DREO.

(d) CFHQ (HFDF) Buildings. This building is now being constructed through DCL by CFHQ. It was intended to have it transferred to DRTE when completed. Under the present circumstances it will be transferred from DND to DOC who will be responsible for all future use and upkeep.

Section 4 - Equipment, Furnishings, Inventories

16. Formal transfer of the lands and buildings as described in Paras 14 and 15 and of the furnishings, inventories and supplies belonging to DRTE will be effected by a further Treasury Board Minute under the provisions of the Rearrangement and Transfer of Duties Act.

PART III - CONTINUING SUPPORT

Section I - General

17. DRB Extramural Program:

(a) Defence Industrial Research Program

The scientific and administrative staff associated with this program, at present located at DRTE, will not be transferred to DOC. They will remain in their present location. DRTE will continue to provide advice and consultation on DIR projects. DRB will be responsible for any travel expenses incurred by DOC staff giving support to this program.

(b) University Grants

University grants relevant to the present field of interest to DRTE will be monitored by the DIR group at Shirley Bay. DRTE will continue to provide advice and consultation on grant proposals and projects in a manner similar to date. DOC will, where possible, provide qualified members for certain of the DRB advisory committees dealing with grant applications in the field of electronics, electrical engineering, solid state physics, etc. Any travel expenses incurred by DOC in connection with the university grant reviews and visits will be borne by DRB.

(c) The Technical Cooperation Program (TTCP)

Subject to the approval of the Chairman DRB, DRTE will maintain the present DRTE participation in TTCP, including the national leadership of subgroups presently held by DRTE staff with the exception of the subgroup dealing with geophysics. Payment for travel on TTCP duties will be the responsibility of DOC.

(d) DRB Foreign Liaison

DOC will endeavour to meet requests for communications/electronics personnel to satisfy the DRB requirement for foreign liaison postings or special missions wherever both civil and defence activities are to be covered.

(e) NATO

Subject to the approval of CDRB, DRTE will continue to supply the Canadian membership in two committees of the AGARD Avionics Panel. It will also attempt to meet requests for ad hoc advice and assistance in connection with the national representations in NATO activities, e.g., in connection with NATO satellite communications systems, on repayment by DRB of any travel expenses incurred.

(f) DRB/NATO Fellowships

DRB has an agreement with several NATO countries to provide a limited number of NATO fellowships tenable at its own Establishments or other government laboratories, depending on the qualifications and training of the applicant. DOC is prepared to accept a limited number of DRB/NATO Fellows. The cost of the fellowships and any associated travel during fellowship tours will be borne by DRB.

18. Security

Basic Principles

The two basic principles are:

(i) as a practical matter, the present system and standards of security be continued;

(ii) as far as military projects, information, visits, domestic or international representation are concerned, DRB must remain the responsible and sponsoring agency.

The particular consequences of these principles involve the recommendations hereunder.

18.1 Security of Personnel

DOC will obtain clearance of all personnel to the standards that their employment demands. The orderly transfer of all existing DRTE personnel security records presently held in DRB/HQ will be made to DOC whenever appropriate and subject to the approval of the Chairman DRB and the RCMP in respect of their information.

18.2 Security of Information (see also Para 29)

DRTE is the repository of a considerable quantity of classified military information in all forms, the use of which is restricted to defence purposes. This information includes Canadian information and a substantial amount of classified information received from other countries, particularly Britain and the United States, the security of which, under international agreement, is vested in DRB on behalf of DND. DRB connot sub-contract the responsibility for the control and custody of this information. To this end, all DRTE holdings of documents classified CONFIDENTIAL or higher, not directly related to current projects taken over by DOC will be withdrawn. Documents in this category required in connection with agreed DND/DRB programs will be listed and re-issued under the security conditions and temporary loan arrangements in the same way DRB issues classified matter on a need-to-know basis to other government departments.

18.3 Classified equipment not retained by DRB will be subject to disposition or transfer and custodial arrangements which will ensure security protection.

18.4 Document Production and Control

Documents produced by DOC in connection with classified projects undertaken on behalf of DND must be referred in manuscript form to DND/DRB for confirmation of security classification and warning terms where applicable and approval of internal departmental distribution. Further distribution and control of such reports will be the responsibility of DRB.

18.5 Application of Security Regulations

The handling, transmission and safe storage of classified information received from or developed on behalf of DRB must conform to the standards of the DRB Security Regulations.

18.6 Physical Security

DOC will continue existing protection for the entire site at present standards with the exception of the intrusion alarm system, the care and maintenance of which will continue to be a DND responsibility.

18.7 Visits

As with other information the responsibility for visit clearances in connection with defence interests cannot be sub-contracted. Regulations governing foreign and local visits are contained in Chapter 9 of the DRB Security Regulations and are applicable in all instances where classified information under the jurisdiction of DRB is concerned. In this respect, authority is vested exclusively in DRB to sponsor classified visits to and to receive classified visits from foreign countries when such visits are made in connection with DND projects or with projects undertaken on behalf of DND.

18.8 It will follow, therefore, that DOC personnel undertaking visits abroad in connection with DND projects or work done on behalf of DND are subject to the sponsorship of DRB in each instance. Likewise, approval for foreign visitors to visit DRTE involving access to DND classified projects or information must be obtained from DRB.

18.9 Security clearance of visits to and from DRTE by DOC personnel and by representatives of the Canadian Government departments and civilian contractors which involve access to classified information on projects undertaken on behalf of DRB must be obtained from DRB.

19. Construction

(a) Major

DRB will continue to be responsible for the management of major construction requirements for DREO. Necessary liaison with the DOC will be done by DRB/HQ and DREO. All completed design for projects previously planned for DRTE will be turned over to DOC.

(b) Minor

Future minor construction projects for DREO will continue to be managed by DRB. The work will be carried out by the engineering section of DOC located at Shirley Bay. Cost estimates will be prepared for DREO by the site engineer upon request. The cost of the work will be borne by DRB on a recoverable basis. This method will also apply for minor construction projects to be carried out for DRB/HQ (DSIS).

Section 2 - DRB to DOC

20. Scientific

At present DOC can foresee only the need for support by the Power Sources Division at the Defence Research Establishment Ottawa.

21. Mail and Jitney Service

Mail and jitney service between the Shirley Bay site and "A" Building is being provided by DND since the major requirement is in DND interest for DRB-NDHQ personnel and their opposite numbers at Shirley Bay. If DOC require an expansion of the service within the City and outlying areas, consideration should be given to a costing arrangement between the two departments.

Section 3 - DOC to DRB

22. Computer Service

Some computer service has been provided hitherto by DRTE to DRB/HQ and DOC will endeavour to continue this service at the level now obtaining, i.e. up to 30 hours per month. It is, however, recognized that the limit of capacity of the existing machine, in two-shift operation, will be reached in early 1969 and that, if the projected new machine is not installed by mid-1969 this service will have to be renegotiated. Continuing computer services for DREO will be provided (see also paragraph 4 (b)).

23. Accommodation and Services

The following accommodation and services will continue to be extended to DREO by DOC:

(a) use of the present scrap area for CADC disposal;

(b) use of a small unheated wing in CEMS Bldg. #8 for warehousing max-min stores stock;

(c) use of the present space allocation in Bldg. #4 to include dining room and cafeteria service when required;

(d) assistance from Technical Illustrations, CEMS Establishment staff (for consultation and advice) and DRTE administrative staff as required;

(e) accommodation for DREO administrative staff and DIR staff.

24. Buildings & Ground Maintenance

After the effective date of transfer, DOC will be responsible for the entire buildings and ground maintenance program. Under the present administration, the funds covering these services to DREO are included each fiscal year in the DRTE budget. These funds will be provided by DRB to cover the services provided by DOC on a recoverable basis.

25. Site Services

Site Services Provided by DRTE to DREO

(i) Cleaning services to DREO buildings, excluding the Biological Wing, Bldg. 5C
(ii) Cleaning services Biological Wing, Bldg. 5C
(iii) Cleaning foreman's time associated with (i) and (ii).
(iv) Housekeeping supplies for labs., washrooms, etc.
(v) Heating of DREO buildings
(vi) Bus service
(vii) Power
(viii) Telephone
(ix) Fire protection
(x) Physical security
(xi) Minor construction projects (contributed labour and materials)
(xii) Upkeep of DREO buildings including maintenance, water, sewage, etc.
(xiii) Incinerator operation and garbage removal
(xiv) Vermin control in DREO building
(xv) Reproduction Centre (material and supplies only)
(xvi) Shirley Bay garage facility
(xvii) Plating Shop services
(xviii) Shirley Bay Cafeteria operations
(xix) Freight and Express pick-ups and outside Ottawa area trips, e.g., animal shavings
(xx) Fuel oil for DREO Flammable Stores Bldg. No. 36
(xxi) Propane gas for DREO Bldgs. 5, 6 and 9
(xxii) Computer Time (less operators)

26. Estimated Costs of Site Services - to appear in the DREO budget and to be transferred to DOC by Financial Encumbrance as required:

(i) Value of cleaning service supplied to DREO buildings, excluding Biological Wing $ 16,800

Details

Bldg # 5 - DREO Main Lab	37,947 sq.ft.
Bldg # 6 - DREO Model Shop	5,237 sq.ft.
Bldg # 9 - DREO Pilot Plant	5,747 sq.ft.
Bldg #24 - DREO Accelerator Bldg	3,396 sq.ft.
Bldg #29 - DREO Animal Bldg. and Extension	2,592 sq.ft.
DREO Area Total	54,919 sq.ft.
Overall Total Area for 1969/70 cleaning contract	197,000 sq.ft.
DREO precentage of cleaning contract	28 %
Cost of cleaning contract 1969/70	$60,000
DREO portion of cleaning contract = 28% of $60,000 =	16,800

Note: Shared Services Bldg., i.e. Guard House, Heating Plant, Central Admin. Bldg., Fire Hall, etc., have not been charged to DREO.

(ii) Annual Cost of cleaning Biological Wing (13,860 sq.ft.) $ 9,600

Details

Salaries of two cleaners (2 x $4,750 = $9,500)	$9,500
Costs of cleaning supplies, including floor soap, germicidal, mop heads etc)	$ 100
TOTAL	$9,600

(iii) Cleaning foreman's time devoted to cleaning DREO areas = 45% of foreman's annual salary of $5,800 $ 2,610

(iv) Housekeeping supplies for DREO Labs, offices, wash rooms including biological wing and not covered by contract $ 546

Details

Germicidal - for wash rooms	$300 per yr.
Hand soap - for washrooms	$ 26 per yr.
Lustre sheen	$ 10 per yr.
Hand towels (20 cases)	$165 per yr.
Plastic Bags for Garbage (1000 per yr)	$ 45 per yr.
TOTAL	$546 per yr.

(v) Annual cost of heating DREO buildings from Main Heating Plant $ 49,585

Details

Bunker "C" oil	$ 34,200
Treatment of boiler water	$ 3,300
Salaries of heating plant personnel	$ 68,000
TOTAL	$105,500

Areas heated:	DRTE	- 149,054 sq.ft.
	DREO	- 134,079 sq.ft.
	DSIS-DRBHQ	- 4,480 sq.ft.
	TOTAL	287,613 sq.ft.

DREO share = 47% of $105,500 = $49,585

Note: This includes shared service on Main site but not test sites.

(vi) Annual cost DREO share of bus service $ 14,850

Details

Bus contract for 1969/70 $55,000
Total no. of employees = 679
DRTE = 497
DREO = 182
DREO share = 27% of $55,000 = $14,850

(vii) DREO share of power costs $ 38,250

Details

1969/70 costs for power at Main Site and all Test Sites $85,000

Areas covered:	DRTE	- 175,383 sq.ft.
	DREO	- 144,800 sq.ft.
	DSIS-DRBHQ-	4,480 sq.ft.
	TOTAL	324,663 sq.ft.

DREO portion = 45% of $85,000 - $38,250

Note: This includes all shared services Bldg., i.e. Guard House, Heating Plant, Central Admin. Bldg., Garage, Fire Hall, etc., and also Test Sites.

(viii) DREO share of telephone costs $ 29,633

Details

Annual charge for service including long distance calls (direct toll charges) and ATA private gov't lines, rental of circuits, rental of telephone and exchange facilities	$80,400
Annual salaries for 2 switchboard operators	$ 8,500
TOTAL	$88,900

Total no. of instruments (1969/70) = 300
DREO usage = 100 instruments
DREO cost for 1969/70 = 33-1/3% of $88,900 = $29,633

(ix) DREO share of fire prevention costs — $ 31,000

Details

1969/70 salaries	$65,000
Cost of maintenance, materials, supplies and equipment	$ 3,850
TOTAL	$68,850

DREO area = 144,800 sq.ft. which equals 45% of all areas
DREO share of cost = 45% of $68,850 = $31,000

(x) DREO share of security costs — $ 32,000

Details

1969/70 salaries	$69,500
Cost of supplies & equipment	$ 1,320
TOTAL	$70,820

DREO area - 144,800 sq.ft. which equals 45% of all areas
DREO share approx. 45% of $70,820 = $32,000

(xi) DRTE annual contribution to DREO minor construction projects — $ 16,600

Work orders under $750

Labour	$ 6,500
Material	4,800
TOTAL	$11,300

Projects over $750

Labour	$ 1,800
Material	3,500
TOTAL	$ 5,300

(xii) DREO share of annual maintenance of Shirley Bay buildings and utilities — $139,500

1969/70 maintenance, including water, sewage, javex, freon gas, salts for water softener - $310,000
On basis of floor space, DREO share is 45% of $310,000 = 139,500

(xiii) DREO share of annual garbage removal costs and operations of incinerator — $ 8,900

Details

2 CFMS employees used collecting garbage - salaries			$ 9,500
Incinerator costs:			
Oil	- $ 2,700		
Maintenance	1,550		
Minor Construction	1,200		
	5,450	TOTAL	$ 5,450
Salary of employee at Incinerator			$ 5,800
		TOTAL	$20,750

Estimate of employees hrs. spent providing this service is approx. 43%

DRTE - 16 hrs. per wk.
DREO - 12 hrs. per wk.

DREO share is approx. 43% of $20,750 = $8,900

(xiv) Vermin control in DREO buildings $ 810

Details

Based on DREO floor space, 45% of 1969/70 estimate of $2,000

(xv) DREO share of operating the reproduction centre $ 2,265

Details

Cost of dennison paper and toner for one year	$ 3,600
Service contract for dennison reproducer	220
Gestetner-paper, mimeograph	1,150
Gestetner-ink, black	465
Ozalid - paper	1,800
- Ammophyll -	275
Pylon Mylar film	35
TOTAL	$ 7,545

DREO share = 30% of $7,545 = $ 2,265

(xvi) DREO share of operating Shirley Bay garage $ 2,450

Details

DREO vehicles (total of 6)

Gasoline	$ 800
Lubricants, coolants, oil	150
Mechanics time	500
Maint. contract	1,100
TOTAL	$ 2,450

(xvii) Plating shop services to DREO — $ 1,100

Details

Approx. 73 hrs. per yr. to complete 23 jobs consisting of 132 units - based on 1969/70 services provided

(xviii) DREO share of operating Shirley Bay Cafeteria — $ 810

Details

Costs of materials, supplies & equipment	$ 3,000 per yr.
DREO share based on ratio of staff is 27% of $3,000 =	810

(xix) Freight and Express pickup service including outside Ottawa area trips — $ 2,000

Details

Costs of operating stores van:

Gas per yr.	$ 275
Oil per yr.	20
Repairs yr.	200
TOTAL	$ 495

Driver spends only 1/2 of time on stores van balance on other vehicles (salary)	$ 2,350
Depreciation of vehicle (based on 5 yrs.)	1,127
Total overall costs	$ 3,972

DREO share should be 50% of overall costs - approx. $ 2,000.

(xx) Fuel oil for DREO flammable stores bldg. No. 36 — $ 329

Details

Approx. 4,700 gals. @ 14 per gal.=	$ 658
DREO share should be 50% of $658 =	329

(xxi)	Propane gas supplied to DREO Bldgs. 5, 6 & 9	$ 264

Details

Bldg. No. 5 - DREO Main lab. approx. 620 gals. per yr. @ .27 per gal	$ 170
Bldg. No. 5 - DREO model shop approx 210 gals. per yr. @ .27 per gal	$ 56
Bldg. No. 9 - DREO pilot plant approx 140 gals. per yr. @ .27 per gal	$ 38
Approx. Total	$ 264

(xxii)	DREO computer time, at machine cost rate (no operators) $1,800 per month =	$ 21,600
	GRAND TOTAL	$421,502

PART IV - TEMPORARY ADMINISTRATIVE SUPPORT BY DRB

27. DRB will continue to provide support services as described below to DOC on the assumption that the objective date for effective operation of DOC is April 1, 1969. It is recognized that services may be required for some additional months but not after July 1, 1969.

28. Personnel

The TB Minute 685824 of January 16, 1969, contained a remark, as follows:

" For the purposes of the Public Services Staff Relations Act, the employees transferred to the Department of Communications shall remain employed by DRB as one of the separate employers named in Part II of Schedule A of the Public Service Staff Relations Act, until the new Department has been established and positions classified for these employees, which is expected to be completed prior to July 1, 1969. In addition DRB will continue to appoint personnel to the Communications Research Centre with the approval of the Deputy Minister (Designate) of the Department of Communications during the above period".

Therefore, the full range of personnel services, as now provided to DRTE, will continue subject to the overall authority of the Deputy Minister of Communications. His authorization and approval will be required for each case of new appointment, promotion or increment at the Communications Research Centre. The Chairman, Defence Research Board in conjunction with the Deputy Minister of Communications will serve as the fourth level in the grievance procedures for DRTE.

29. Information Services (see also Para 18)

(a) Printing and binding of documents originating in DRTE.

(b) Distribution and mailing of DRTE documents.

(c) Provision from or through DSIS of documents requested by DRTE and continuing consideration of the needs of DRTE when deciding upon circulation by DSIS of documents received. DRTE will continue to provide to DSIS reprints of its publications in the open literature.

(d) Continuation of the supply of periodicals to DRTE from the DND/DRB Library.

30. Finance and Supply Services

These will continue to be provided by DRB as required.

MEMBERS OF THE STAFF OF THE DEFENCE RESEARCH TELECOMMUNICATIONS ESTABLISHMENT TRANSFERRED FROM THE DEFENCE RESEARCH BOARD TO THE DEPARTMENT OF COMMUNICATIONS

SCIENTIFIC AND PROFESSIONAL

ALLAN, DP	ALLARD, PE	BARRINGTON, RE	BARRY, JN
BELROSE, JS	BESHARA, JN	BIBBY, RJ	BLOOM, JN
BONNEYCASTLE, RJ	BOULDING, JDR	BOWEN, RR	BOWN, HB
BRADT, DD	BRIDGEWATER, AWL	BUTTERWORTH, JS	CHAMBERS, JG
CHUDOBIAK, WJ	CLOWES, GJ	COLLINS, CW	COX, CD
CRYSDALE, JH	DAVIES, NG	DAVIS, WA	DAY, JWB
DOHOO, RM	DOUVILLE, PJR	ECKHART, LS	EDWARDS, WD
EHLERT, LB	EVANS, WM	FLORIDA, CD	FRANKLIN, CA
FUJAROS, RG	GARLAND, MG	GARRETT, TW	GEORGE, DA
GILCHRIST, AWR	GORDON, BA	GRANT, HM	GREEN, FD
GRUNO, RS	HARA, EH	HARTMAN, WA	HARTZ, TR
HARVEY, RW	HATTON, WL	HENDERSON, DP	HERRING, RW
HERZBERG, LH	HILL, KO	HINDSON, WD	HORITA, RE
HOYT, DP	HUVA, J	IRVINE, GW	JELLY, DH
JOHNSTON, JW	JULL, GW	KAYE, AR	KOWALIK, H
LACEY, WK	LANGILLE, RC	LOCKWOOD, GFK	LUSICK, PJ
MacLEAN, MA	MAR, J	MATSUSHITA, JS	MAYNARD, LA
McCASKILL, DR	McCORMICK, KS	McEWEN, DJ	MILNE, RMT
MOLOZZI, AR	MONTBRIAND, LE	MULDREW, DB	NELMS, GL
NISHIZAKI, T	NOTLEY, GR	NUSPL, PP	PAGE, DF
PAGHIS, I	PAWZIUK, WJ	PETRIE, LE	PRAGNELL, HF
RAINE, NR	REYNAUD, AH	RICE, DW	ROSCOE, OS
ROSS, DB	ROYER, GM	SEAMAN, EA	SEGAL, B
SHEPARD, CD	SIMPSON, FW	SMITH, FE	STRICKLAND, JI
SYMONS, FW	THOMSON, WA	THREINEN, WF	VENIER, GO
VIGNERON, FR	WALKER, BA	WALKER, EA	WARREN, ES
WATANABE, A	WEBBER, RV	WERSTIUK, HL	WOHLBERG, DR

ADMINISTRATIVE AND FOREIGN SERVICE

ANDREWS, RS	ATKINS, E	CHECKLEY, HE	FISHER, JR
KENNEDY, JD	KIRKPATRICK, J	OSBORNE, TA	POPE, WA

TECHNICAL

ADAMS, AF	ANGERILLI, AGA	AYRE, S	BAKER, RF
BARDEN, TC	BARLOW, DJ	BARNES, DC	BEACH, MHE
BEDAL, KG	BENNETT, DA	BENNETT, JP	BILODEAU, R
BINGHAM, JA	BIRD, GT	BODE, LR	BOURDON, RR
BOWER, GG	BRADLEY, DR	BREE, AL	BREE, GG
BRIDGE, AWL	BROWN, JWG	BRUER, GC	BUCHOLTZ, H
BUCKMASTER, FA	BUNKER, R	BURNS, DW	BUTLER, DL

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TECHNICAL - continued

BUTLER, PR	CALDWELL, JD	CAMPBELL, WS	CHARBONNEAU, JJ
CHARRON, JRRD	CHIN, WA	CHOWNS, JE	CHRISTENSEN, JA
COLBERT, JE	COLLINS, JA	COTE, OL	COYNE, WR
CRAIG, AJ	CRAIG, GB	CROSS, FR	CROWE, RL
CUNNINGHAM, WRG	CURRY, RD	CZAHARYNSKI, M	DANIELS, F
DAVIDSON, DA	DAVIS, LS	DEGUIRE, RA	DOHERTY, EP
DUCHARME, ED	DUFF, G	DURANCE, RA	EISENHAUER, LR
ELSE, J	ENNS, JG	EVERS, RM	FAIRE, DR
FINES, NR	FRAYN, HC	GAGNON, AE	GAUMONT, G
GAY, HV	GIROUX, DB	GODDARD, DA	GOODMAN, VA
GOW, DH	GREEN, TE	GRIFFIN, JM	GROSSKLEG, KW
GUSTAFSON, KC	HAGG, EL	HAGGAR, LG	HAHN, RF
HANCHAREK, J	HANNAM, KJ	HARRIS, PL	HARRISON, NA
HART, AW	HASKELL, WF	HEWENS, E	HEWITT, LW
HILL, AE	HITCHCOCK, NS	HOPKINS, J	INRIG, SA
IRVING, RH	JACKSON, AH	JACQUES, P	JOHNSON, E
JUDD, DL	KEMP, SJ	KENNEY, JB	KITCHING, RA
LABELLE, LA	LAMPMAN, JH	LAMONT, RG	LAWLOR, LR
LAYEUX, GJ	LEDUC, JP	LEMIEUX, JO	LEONARD, RJ
LEUS, WW	LINDLEY, TW	LISSON, BR	LONG, WR
LOVELOCK, MH	MACKIE, GHC	MacLELLAN, MA	MacMILLAN, HL
MAIONE, AP	MALONEY, MR	MATHER, WE	MATHIE, HT
MATT, EE	McCLEARY, JVE	McCLELLAND, HK	McEWEN, AH
McKERROW, CA	McLENACHAN, PR	MILLS, ST	MOFFATT, JA
MOHR, KV	MOORE, EJ	MORRISON, AB	MOSS, GE
MUNROE, DC	MURPHY, PD	MURRAY, CF	NELSON, WW
NICHOL, HR	NIELSEN, HO	NOYES, RE	OHNO, T
OREGAN, WT	OROSZ, JAI	PAGE, JAD	PAQUETTE, JP
PAYEUR, GJ	PERRIER, EL	PHILLIPS, WG	PINKNEY, GR
POAPS, GE	POIRIER, AL	PSUTKA, ME	RANDALL, CJ
RAYMOND, JP	REED, GN	RODERMOND, F	ROLFE, W
ROOK, BJ	SAWTELL, JE	SCHREIBER, B	SELIN, DL
SELWYN, DM	SHAVER, GL	SHEPPEY, JC	ST AMAND, JRG
ST GERMAIN, MJ	STAPLEY, AG	STANLEY, OE	STEVENS, EE
STOFFELS, M	STONE, TH	STOREY, JR	TAYLOR, LH
TENNUCI, JE	THIBAULT, J	THOMAS, JL	THOMPSON, WE
TIGGES, WS	TIMLECK, PL	VAIL, FT	WALKER, MGL
WARBURTON, RE	WARWICK, JA	WATTS, EL	WHITFORD, HA
WILLIAMS, EG	WINACOTT, EL	XHIGNESSE, JP	YANK, RR
ZAY, M			

ADMINISTRATIVE SUPPORT

ARBIQUE, MJ	BRAUN, PL	BRENNAN, GJ	CALIXTE, CP
CARDILLO, HI	CARROLL, MS	CARTWRIGHT, GC	COX, ER
DELAHUNT, CA	DELORME, CA	DEWOLFE, MJ	DOUGHERTY, ME
FERGUSON, HN	FIEGENWALD, EE	GINN, VJ	GREGORY, ML
GUTHRIE, AA	HALL, MC	HAY, JE	HERST, ME
HODGINS, KBG	HUGHES, LG	JACKSON, DAL	JOHNSON, JA

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ADMINISTRATIVE SUPPORT - continued

KAVANAGH, KW	LACOSTE, MC	LAKE, RH	LANGTRY, NA
LANTHIER, KE	LEPINE, G	LEVEILLE, HM	LINDSAY, HA
LYNCH, MT	MacDONALD, MF	MacDONALD, JJ	MAGALOS, I
MAJAURY, DJ	MAJOR, PDA	McCANN, VH	McKAY, KR
MITCHELL, JA	MOYLE, RN	NOONAN, D	NORTON, CE
PAYNE, GF	POST, EJ	POTTER, MC	QUINTAL, RJ
RENIER, B	ROBERTSON, EE	ROLFE, EO	SALTER, ER
SCANLAN, K	SCARCELLA, FM	SCOTT, AMG	SPARROW, OI
STEELE, DI	STEELE, LG	THOMPSON, EM	TORRANCE, MH
TROTT, FJ	VANASSE, LSM	WHEELER, SL	WILSON, MDA
WIMPERIS, WG			

OPERATIONAL

ANDREWS, RJ	ARMSTRONG, PJ	BECK, GA	BERUBE, E
BERGER, E	BILLINGS, H	BILLINGS, KE	BLAIR, H
BORUTSKI, JR	BRENNAN, JP	BROWN, CE	BROWN, JWG
BRUCE, MH	CARROLL, I	CHIASSON, D	CORNEAU, CA
COWAN, EB	CUNNINGHAM, VE	DALLAIRE, F	DICK, GH
DOHERTY, JD	DOWNEY, TG	DRYNAN, RH	EDWARDS, CJ
FORTIN, LB	FOURNIER, JL	GAULT, EW	GODDARD, WF
GOW, HK	GOWAN, WF	GRAHAM, JD	HALL, EE
HAMMILL, EO	HARRIS, P	HILL, JD	HOLMES, NE
HOOTEN, JW	INGERSOLL, WF	JONES, NV	KEALEY, LA
LAVERGNE, JJ	LAWSON, GJ	LEPAGE, W	LETTS, KS
LITTLEFIELD, AL	MacGILLIVARY, WL	MacKINNON, HA	MAJOR, TO
MARSHALL, AW	McCONNELL, V	McGILVERY, LH	McNEIL, MF
MOODIE, WCT	MOODIE, FA	MOORE, WE	MOULTON, RC
MULDOON, FB	OREILLY, RA	PAYNE, CH	POPE, LJ
READ, AD	REIJNEN, JC	RENAUD, RH	ROBERT, JP
ROY, RR	SAUVE, JHA	SENECAL, O	SHORT, TE
THACKER, H	TRICK, G	TURNER, LH	WILLIAMS, CF
WILSON, JB	WILSON, JJ	YADE, PC	

CASUAL

ANDREWS, L	ARMSTRONG, CH	ARMSTRONG, WT	BARDEN, JL
BOLTON, GP	BURNS, AJ	CAMPBELL, GI	CARROLL, A
CHARLEBOIS, A	CLAPP, JE	CLEMENT, DO	CLEMENT, GP
CRAIG, EE	DAGENAIS, BP	DALY, PA	DEFALCO, L
EMON, BJ	ENO, D	GILMOUR, AM	GLISINSKI, M
HOLBROOK, T	KEMPSTER, KJ	LARSEN, C	LETTS, G
MacDONNELL, JS	McGRATH, MK	McKENNEY, PJ	McLEOD, GG
MULDOON, FJ	NAVIN, R	NEELY, L	PORTT, GR
ROCQUE, CJ	ROSE, BA	ROSS, D	RYAN, R
SAUNDERS, ET	SAUNDERSON, R	SCHARF, LN	SCHARF, JR
SMITH, RA	ST GERMAIN, G	THACKER, LJ	THOMPSON, WF
VAN EYK, WJ	WILLOUGHBY, DG	WILSON, HI	WILSON, L

APPENDIX V

THE FRASCATI DEFINITIONS OF RESEARCH AND DEVELOPMENT

Not all research has the same goal. The general classes of research are usually defined in terms of the assumed motivation for the work. Statistics Canada uses the following definitions of basic research, applied research and experimental development. (cf. "Federal Government activities in the Natural Sciences, 1972/74, Statistics Canada, Oct., 1973, pp. 60-61. These are the so-called "Frascati definitions".)

1. "Basic Research is original investigation undertaken in order to gain new scientific knowledge with the primary purpose of contributing to the conceptual development of science. The motivation is to increase the accumulated, objective and systematic knowledge of the inherent properties and interactions of matter, space, energy, natural phenomena and biosystems.

   "In free (unoriented) basic research the original impulse comes mainly from scientific curiosity. Oriented basic research, more typical of the basic research conducted by the federal government, is directed towards the definition and solution of fundamental technical and scientific problems in a general area of interest.

   "Basic research yields new hypotheses, theories and general laws. The resulting information is usually non-negotiable and freely published and circulated. The results often affect a broad field of science and may have a number of ultimate applications."

   Note that insofar as the department is concerned, it does not support or engage in free basic research, and only a very small fraction of departmental resources are devoted to oriented basic research.

2. "Applied Research is original investigation undertaken to gain new scientific knowledge with the primary purpose of applying such knowledge to the solution of practical or technical problems. It is required to determine possible uses for the findings of basic research and to select the appropriate method of achieving some specific and pre-determined objective.

   "The results of applied research generally apply to a limited number of products, operations, methods or systems. Ideas are developed into operational forms. The knowledge or information derived is often patented."

3. "Experimental development is the application of scientific knowledge to produce specific new materials, devices, products and processes or to make technically significant improvement in existing ones. It consists of systematic work whose objective, drawing on existing knowledge, is to provide the technical elements of a decision to produce new materials, devices and products or to implement new processes and systems for commercial sale or operational utilization. This would include pilot plant and prototype design and testing."