Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

TELIDON RESEARCH AND DEVELOPMENT

Background Study

Étude préalable

JANUARY, 1988

PROGRAM EVALUATION ◦ DIVISION ◦ DE L'ÉVALUATION DES PROGRAMMES

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January, 1988 (Revised)

DOC
PROGRAM EVALUATION SERIES

This is one of five Background Studies that form part of the evaluation of the Telidon Program.

This study was conducted by Destrier Management Consultants for the Program Evaluation Division of the Department of Communications, Canada.

The views expressed herein are the views of the author and do not necessarily represent the views or policies of the Department of Communications.

La présente est une des cinq études préalables fond portant sur l'évaluation du programme Télidon.

L'étude a été entreprise par Destrier Management Consultants pour le compte de la Division de l'évaluation des programmes du ministère des Communications.

Les recommandations concernant les politiques et les programmes ou les points de vue exprimés, ici, sont ceux de l'auteur et ne reflètent pas nécessairement ceux du ministère des Communications ou les politiques du ministère.

EXECUTIVE SUMMARY

This evaluation focuses on the impact of the research and development activities of the Telidon Program. It is part of the overall evaluation of the program. Approximately $15 million in research and development was spent by DOC on the Telidon program, while other departments invested another $7 million. It is estimated that the government's contribution represented only about 25% of total research and development expenditures on Telidon, the remainder being made by the private sector.

The evaluation examines the impact of Telidon R&D in four areas: research and development strategy, technology transfer, the selection of companies, and the ultimate research results.

To provide a context for examining Telidon research and development we have described a model of normal research and development activities. This model includes the explicit definition of a research and development strategy and the identification of factors ensuring the successful transfer of technology to the private sector. This includes the necessity of a high quality research team, commitment by senior management, and particularly, the adaptation of the research and development effort to technical and market problems, orienting itself more toward "market pull" than "technology push."

Throughout the program, the Telidon research and development strategy involved support of the field trial experimentation with evolving prototypes in hardware and software, as well as working towards lowering hardware costs through innovation. This strategy was consistent with the overall program objective and remained essentially unchanged throughout. Necessarily the activities supporting this strategy changed as the program evolved from 1979 to the present, but remained in support of the overall program strategy and ensured its successful transfer to the private sector.

The Telidon research and development strategy contained two critical components for the success of the technology transfer. First, it involved first rate scientists, engineers, and other researchers which, as a result, caused Telidon to be adopted in 1984 as the core of the North American standard in videotex. Second, it involved senior management who were directly involved and committed to the exploitation of Telidon, and to the research and development necessary to ensure this from the beginning of the program. The projects were highly directed and the mandates and statements of work were clear. As such, there were no significant problems with focus, late delivery, or quality.

With respect to equipment technology transfer, Norpak was the lead company supported, along with several others who are all still involved (e.g., Electrohome, New Media Technologies). At the present time, the first low cost terminals are being produced and Norpak is linked through into Samsung of Korea to access the extensive potential of North American and Pacific Rim markets for videotex/teletext decoders, especially the latter. The second type of technology transfer involved software and was done through extensive contracting out by CRC to programmers and analysts. This was accomplished largely by the transfer of knowledge and people and, as a result, created a widely-respected Telidon software and consulting industry in Canada. This industry enjoys a worldwide reputation and regularly exports its products.

When compared to the technology transfer of NATAL at the National Research Council, the Telidon technology was more successfully transferred, albeit with higher resourcing.

In summary, the research and development effort involving the development of products and transfer of expertise and knowledge to companies did indeed contribute to the development of a Canadian videotex industry. It is not possible to answer all of the evaluation issues and questions with the precision one would like. However, the available evidence supports the conclusion that the research and development component of the program effectively contributed to the creation of this industry through its research strategy, subsequent company selection, and ultimate research results.

SOMMAIRE

La présente évaluation, qui s'inscrit dans l'évaluation globale du programme, porte sur l'incidence des activités de recherche et de développement du Programme Telidon, au titre duquel le ministère des Communications a consacré près de 15 millions de dollars en recherche et développement, tandis que d'autres ministères ont investi un autre 7 millions. La participation financière du gouvernement aurait représenté seulement 25 % des dépenses totales des travaux de recherche et de développement axés sur Telidon, le reste provenant du secteur privé.

Les évaluateurs ont examiné l'impact de ces travaux dans quatre secteurs : la stratégie de recherche et de développement, le transfert technologique, le choix des compagnies et les résultats définitifs de la recherche.

Pour situer dans un contexte l'examen des travaux de recherche et de développement portant sur Telidon, nous avons décrit un modèle d'activités normales de recherche et de développement, lequel comprend, d'une part, la définition explicite de la stratégie de recherche et de développement et, d'autre part, la détermination des facteurs assurant la réussite du transfert de la technologie au secteur privé. Cela suppose la nécessité d'une équipe de recherche hautement qualifiée, l'engagement de la haute direction et, plus particulièrement, l'adaptation de l'effort de recherche et de développement aux problèmes techniques et à ceux du marché, effort guidé davantage par les impératifs du marché que par la poussée technologique.

Tout au long du programme, la stratégie de recherche et de développement reliée à Telidon a été articulée autour de l'appui des expériences sur le terrain, au moyen de prototypes sans cesse mis au point de matériel et de logiciel, et de l'innovation axée sur la réduction des coûts du matériel. Cette stratégie était conforme à l'objectif global du programme et est demeurée essentiellement inchangée du commencement à la fin. Même si les activités appuyant cette stratégie ont nécessairement évolué au fur et à mesure du déroulement du programme, de 1979 jusqu'à aujourd'hui, elles ont toujours appuyé la stratégie globale du programme et assuré le succès du transfert au secteur privé.

Ce succès reposait sur deux éléments critiques dont, premièrement, des scientifiques, ingénieurs et autres chercheurs de premier ordre, à qui l'on doit l'adoption de Telidon en 1984 comme étant le coeur de la norme nord-américaine du vidéotex, et deuxièmement, la participation directe et l'engagement de la haute direction à l'égard de l'exploitation de Telidon et des travaux de recherche et de développement nécessaires à cette fin et ce, d'entrée de jeu. Les projets étaient hautement dirigés et les mandats et les énoncés de travail étaient clairs, si bien qu'il n'y a pas eu de problèmes importants de convergence des efforts, de livraison tardive ou de qualité.

En ce qui concerne le transfert de la technologie de l'équipement, Norpak a reçu la plus grande part d'appui, de même que plusieurs autres entreprises qui participent encore au programme (p. ex. Electrohome, New Media Technologies). A l'heure actuelle, les premiers terminaux à prix modique sont en voie de production, et Norpak est reliée, par l'intermédiaire de Samsung de Corée, aux importants marchés potentiels d'Amérique du Nord et des pays de la côte du Pacifique pour les décodeurs de vidéotex et de télétexte, surtout ces derniers. Le second mode de transfert technologique a porté sur les logiciels, et il a été effectué au moyen de nombreux contrats adjugés par le CRC aux programmeurs et analystes. Cela a été réalisé en grande partie par le transfert des connaissances et des ressources humaines, d'où la création

au Canada d'une industrie hautement respectée de logiciels Telidon et de services consultatifs, laquelle jouit d'une réputation mondiale et exporte régulièrement ses produits.

Lorsqu'on le compare au transfert technologique du projet NATAL du Conseil national de recherche du Canada, le transfert de la technologie Telidon a connu plus de succès, bien qu'il faille admettre que des ressources plus importantes ont été mobilisées à cette fin.

En somme, l'effort de recherche et de développement ayant débouché sur la mise au point de produits et sur le transfert de compétences et de connaissances aux entreprises a bel et bien contribué au développement d'une industrie canadienne du vidéotex. Il est impossible de répondre avec autant de précision que l'on voudrait à toutes les questions que soulève pareille évaluation; toutefois, tout permet de conclure que la composante recherche et développement du programme a effectivement permis la création de cette industrie, grâce à sa stratégie de recherche, à la sélection subséquente des entreprises et aux résultats définitifs de la recherche.

TABLE OF CONTENTS

1. INTRODUCTION

This study is one of six studies which were carried out to evaluate the Telidon program. It is an assessment of the impact of the research and development activities of the program. The focus is primarily on the process by which the Telidon technology was transferred to the private sector and the role that continued research and development had in the establishment of the commercial Telidon product for industrial development.

It is estimated that the Department of Communications invested approximately $15 million in research and development associated with the Telidon program. Other government departments, including the National Research Council and the Department of Regional Industrial Expansion, invested another $7 million in research and development activities, to support the Telidon program objectives. Estimates of industry spending on Telidon research and development range from 80 to 200 million dollars.

The evaluation was to identify the impact of Telidon research and development in four different areas: research and development strategy, technology transfer, the selection of companies, and the ultimate results. The specific questions addressed in each of these areas are outlined in the second section.

The underlying approach in addressing each of the evaluation issues was to collect information on each of them. We then compared the impact of the Telidon research and development and its transfer to what might have been expected in the normal management of research and development and its progression to a marketable product.

Section two of this report describes the detailed evaluation questions and issues, and the methods by which information was gathered on these issues.

Section three of this report then identifies a basic model for research and development and technology transfer. This provides the structure within which we examine the Telidon research and development activities and impacts. The discussion includes general and institutional factors affecting research and development as well as those affecting technology transfer.

The first evaluation issue, Telidon R&D strategy, is the subject of section four. The process of strategy development is traced from pre-Telidon to current R&D activities.

The fifth section of the report deals with the transfer of technology developed by Telidon R&D. As well, it examines the way this was effected compared to the transfer of NATAL R&D from the National Research Council. Section six deals with the companies who received direct and indirect technology transfer, how the transfer was effected, and how they were selected. The process of selection of companies and the consequences of the selection are discussed.

Section seven of the report discusses R&D results. In this section, the objectives and strategies are related to results, both direct and indirect. Finally, section eight is a concluding discussion of the issues and questions.

2. ISSUES AND METHODS

Before examining the impact of Telidon research and development, it is useful to present the questions examined in the evaluation of Telidon R&D. Four evaluation issues which were identified in the introduction were explored by seeking answers to a set of 16 questions described below.

2.1 R&D Strategy and Activities

1. What was the Research and Development strategy of the Telidon program and how did this strategy relate to overall program strategies?
2. How was this strategy developed?
3. What Telidon interests had input to the R&D strategy development process?
4. Did this strategy change over the course of the program?
5. What proportion of DOC funded research projects were completed? On time?
6. What proportion of total Telidon R&D was DOC funded?
7. What proportion of DOC funded research was eventually incorporated into Telidon systems?

2.2 Technology Transfer

8. Were research results made available to relevant parties? How?
9. What linkages were established between researchers and producers and users of Telidon?

2.3 Companies Selected

10. Which companies received the benefits of government R&D?
11. How were these companies selected?
12. What were the consequences of these selections?

2.4 Results

13. Were problems identified by the users and the industry?
14. If yes, were they solved by the Telidon research program?
15. Were the R&D results available when needed?
16. What beneficial spin-offs occurred as a result of Telidon R&D?

The above questions served as the basis for collecting information about Telidon research and development and its impact. Four principle methods were used for gathering information on the above evaluative questions.

Data Review: We reviewed existing data available from DOC on amounts spent on R&D for each contract in each year. We reviewed annual project lists for each contractor for several years. Where possible we compared departmental data with corporate data.

Actual data, where available, was matched against data taken from Treasury Board submissions and Operational Planning documents.

It should be noted that the data available from the different sources was not always complete or consistent. However, for purposes of this report wherever possible, the actual data was used.

The basic information on what DOC funded in R&D from DOC files and records is contained in Appendix A.

File Review: We reviewed files in three different areas. The Treasury Board and Policy files were reviewed in order to determine how R&D strategy was developed and how it changed over time.

We reviewed contract files at headquarters and at the Communications Research Centre to determine what kinds of projects were being funded by DOC as part of Telidon R&D, what kinds of Telidon products were being developed, and the technical problems to be addressed and overcome by R&D efforts and the companies involved.

The third aspect of the file review was to verify to the extent possible the basic information on R&D contracting as contained in DOC records and data.

Interviews: We interviewed people currently or formerly employed by DOC in the Telidon program in order to verify the data gathered and the information developed from the file reviews.

To develop additional information on the participation of other government departments in Telidon R&D efforts, we interviewed managers in the principal departments involved: DRIE, NRC and DSS.

A third set of interviews was carried out with managers of some of the major Telidon companies and with Canadian Patents and Developments Ltd. to obtain their perspective on the Telidon R&D effort.

Case Studies: After completing the initial file reviews and interviews, we identified a series of companies that had benefited from the transfer of technology from DOC's labs and/or were recipients of significant funds from DOC to carry out R&D or innovation projects for DOC.

For case study purposes, additional interviews were carried out to determine the chronology of events, the manner in which technology was transferred, the R&D projects undertaken, and the results of these activities.

3. RESEARCH AND DEVELOPMENT AND TECHNOLOGY TRANSFER

To evaluate the effect of Telidon research and development and its transfer to the private sector, it is important to have a basis on which to make an assessment. Much has been written about research and development and its transfer into economically productive activities. A short bibliography on that subject is included at the end of this section.

A brief examination of research and development is useful to identify the types of activites and management that are usually included under that rubric. Figure 1 shows the transition from basic research, which may or may not be related to market demand, to the existence of a product, process, or service, ultimately to be sold (see references 9 and 10 for elaboration of this).

The intention of Figure 1 is to describe not only the different types of activities contained in research and development, but also to show how the transition between these activities is managed. This is done through development of an initial research and development strategy, technology transfer, the selection of companies, and finally, the achievement of market results. Figure 1 illustrates that in order for the transition to occur between the relatively homogenous research activities (for example, those undertaken within basic research, within applied research or within product development) it is necessary to have a strong hand in the management to ensure that the transition is done in a way, and within a time frame, that will ensure a marketable product. Obviously, some steps may be skipped or may be repeated several times in any actual research and development activity, as it goes from basic research to market entry. Nevertheless, what can be seen is that the basic issues which are identified and addressed in this report are those required to undertake the transition between the different research and development activities themselves.

What the figure demonstrates rather clearly is that the subjects to be addressed here relate more to the management of R&D and its transition between various steps (with the resultant impacts) than to the actual research activities themselves. This is of course exactly what would be expected in an examination of the Telidon program. Here, the concern is not with the technical research results per se which led to the exploitable commercial opportunity, but instead, with the way in which these results evolved into a marketable product or process and how management achieved these new outcomes.

In order to measure the impact of research and development management, some authors spend a considerable amount of time on input or process indicators. A set of indicators could include measurements of productivity of individuals or groups (such as papers produced), basic product management, training, contract R&D management, union administration, job descriptions, communication links, technical capabilities, R&D facilities, promotions, job enrichment, performance appraisals, and other indicators - mainly of process activities.

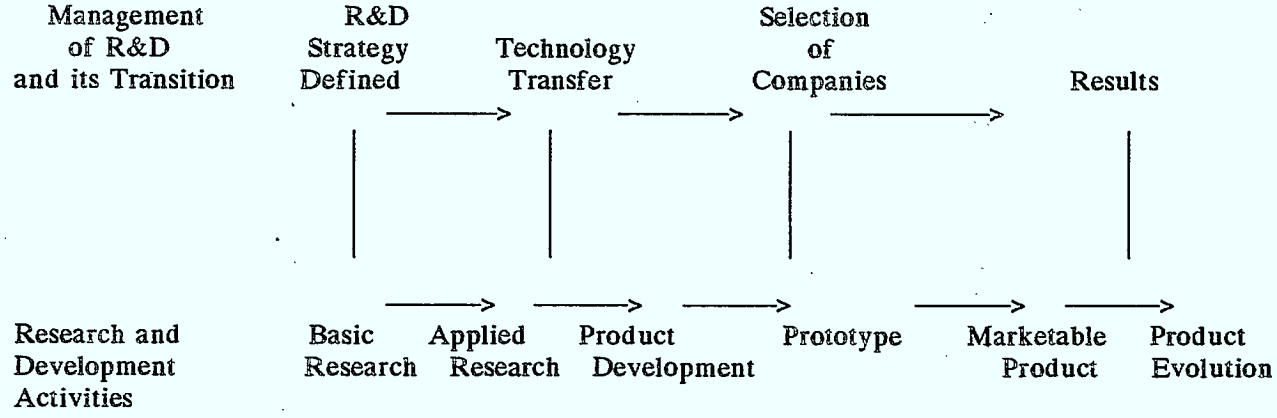
Other authors identify more general indicators also oriented to both inputs and outputs. Inputs could include such things as:

- resources
- plant
- people
- proportions spent on R&D

FIGURE 1

RESEARCH AND DEVELOPMENT

AND ITS TRANSFER



Output indicators might include:

- papers
- patents
- new products
- income
- profit
- scholarly honours
- a "surprise index" (in terms of unexpected and beneficial developments)

In examining the basic management activities identified in Figure 1, we will have certain expectations. The research and development strategy should have been clearly articulated and have shown an explicit means by which the basic research could be transferred to the market place. Indeed, in order to ensure that such a transition takes place clearly there are a number of preconditions one might expect to have evident (see for example References 1, 2, 4 and 5). At an institutional level one would have expected a solid investment in the underlying research and development. As well, one would expect to see high calibre persons working on the project and in close proximity to the market place. In this regard there should be a strong "market pull" for the product (versus "technology push").

It is interesting to note that the quality, energy, and commitment of technical and research staff is somewhat in conflict with making a realistic assessment, at the strategy level, of the risks involved to enter the market place. The degree of commitment required by researchers suggests that they may be somewhat more optimistic than they should be of the chances of success in such markets. Nevertheless, both a realistic assessment of risk and a strong commitment are necessary to succeed. There also must be strong commitment of senior management to ensure that such research makes the transition between the relatively homogeneous stages of research activity required before final entry into the market place.

In subsequent sections we will see to what extent the research and development strategy and, particularly, the management of technology transfer, satisfied the requirements we have identified above.

The research and development strategy should have explicitly identified how the technology already developed in CRC was to be translated into a marketable product. As well, the responsibility for the product and its associated services should solidly exist in the private Canadian sector. More specifically, we will examine the research and development strategy to see if its translation into activities adapted to the technical and market problems. The extent to which the above identified conditions existed for successful technology transfer will then be examined. This will assist in determining if there were preventable problems or notable achievements during the research and development associated with the Telidon program. We will also describe the process of activities undertaken to actually do the Telidon research and development (through company selection). This will be followed by an examination of the actual results achieved through research and development and conclusions as to the success in the management of the research and development program associated with Telidon. Throughout this, our concern will be to examine the research and development strategy and activities with respect to the factors which have been identified above.

References: Section 3

1. "Canada Tomorrow Conference, Proceedings," November 6-9, 1983, Ministry of State for Science and Technology, 1984.

2. "Canada Tomorrow Conference Commissioned Papers," Nov. 6-9, 1983, Ministry of State for Science and Technology, 1984.

3. Program Evaluation Report, Program for Industry/Laboratory Projects (PILP) Component, March 1, 1984, National Research Council.

4. "Technology Transfer by Department of Communications: A Study of Eight Innovations," B. Bhaneja, J. Lyrette, T.W. Davies and R.M. Dohoo, Department of Communications and Ministry of State for Science and Technology, 1980.

5. "The Role and Function of Government Laboratories and the Transfer of Technology to the Manufacturing Sector," A.J. Cordell and J. Gilmour, Science Council of Canada, April 1976.

6. "TaskForce on Federal Policies and Programs for Technology Development," A Report to the Honourable Edward C. Lumley, Minister of State for Science and Technology, July 1984.

7. "Transfer of Computer Aided Learning Technology - A Case Study," Program Evaluation Office, National Research Council of Canada, April 1984.

8. Barry Bozeman, Michael Crow and Albert Link, "Strategic Management of Industrial R&D," 1984, D.C. Heath and Company.

9. Herbert I. Fusfeld and Richard N. Langlois (editors), "Understanding R&D Productivity," Perganon Press, 1982.

10. Robert R. Blake and Jane Srygley Mouton, "How to Assess the Strengths and Weaknesses of Research and Development," Scientific Methods Inc., Austin, Texas, 1972.

11. B.V. Dean and J.L. Goldhar, "Management of Research and Innovation," Studies in Management Science, North Holland Publishing Co., 1980.

12. Thomas E. Clarke, "R&D Management Bibliography 1981," Storgate Consultants Limited, 1981.

13. Donald J. LeRoy and Paul Dufour, "Partners in Industrial Strategy: The Special Role of the Provincial Research Organizations," Science Council of Canada Background Study #51, November, 1983.

4. TELIDON RESEARCH AND DEVELOPMENT EVENTS AND STRATEGY

One of the issue areas to be addressed by this study was the R&D strategy development process. This involves identification of the strategy, its relationship to overall program strategies, its development, the Telidon interests that had strategic input, and how the strategy changed over the course of the program.

The R&D strategy of the Telidon program developed as follows:

Pre-Telidon (1969-1973):

- an interactive visual communications system, called Picture Discrimination Instructions (PDIs), was developed for military applications to be transmitted over telephone lines
- this technology was identified as a potential videotex application for business

Telidon Program (1979-1983):

- a prototype was developed for use in field trials in response to competition for demonstration of videotex system
- first, hardware, content, and system software needed to be developed to produce an operating system for telephone, broadcast, and cable transmission trials
- second, low cost hardware had to be produced to become price competitive, both through very large scale integration (VLSI) microcomponent technology and larger mass production for mass audiences
- third, the adoption of the North American Presentation Level Protocol Syntax (NAPLPS) Handbook, based on Telidon, widely throughout North America and elsewhere

Telidon Exploitation Program (1983-1985):

- continued prototype development of second generation systems to meet the NAPLPS standard and reflect the commercial needs identified in the field trials
- return to some basic research on videotex and teletext enhancements relating to error control, image codification, page creation, VLSI development, mobile Telidon and others.

In summary, the research and development strategy for Telidon was to develop an application of the technology and this remained constant throughout the program.

Initially, the program was concerned with prototype development and enhancements and subsequently with field trials and further enhancements (including lower cost hardware). All of these strategies were to support the eventual development of Telidon as a marketable product and service. The translation of the strategy into activities evolved as a result of changes in the market and in its eventual adoption as the de facto North American standard for videotex and teletext. Thus, the general strategy remained constant, but with specific

changes in its translation in response to evolving market needs throughout the period of 1979-1985. We will now examine that evolution of activities.

4.1 Pre-Telidon Strategy:

"Telidon" evolved from research conducted at the CRC on interactive graphics display systems. The picture description instructions (PDIs) coding developed at CRC for graphic images "permitted all communicating parties equal ability to modify, generate, or perform calculations concerning all displayed material, using only narrow bandwidth communications lines."[1]

The initial strategy was to develop an application of the technology for the Department of National Defence to allow geographically separate locations to communicate graphic images between locations more or less simultaneously over narrow bandwidth lines (telephone lines).

In December 1975, NORPAK submitted a request to Canadian Patents and Development Limited (CPDL) for a license for software and hardware components of an interactive graphics display system developed both in-house by DOC and by contract with NORPAK.[2] A formal submission of an 'Interactive Visual Communication System' (IVCS - Case 6240) was received by CPDL in March 1976, and one for 'Interactive Graphics Programming Language' (IGPL - Case 6523) was received in April 1977. In March 1978, the license for technology transfer was executed by NORPAK.

At this point, the R&D strategy was changed to modify the systems for videotex demonstration. A promotional campaign was launched by DOC to stimulate government interest in the Canadian technology. The campaign was successful and CRC was allocated $2.4 million to develop a simulation of Prestel. On August 15, 1978, a public demonstration of the Canadian videotex system was presented at a DOC press conference. The system's name, "Telidon," was coined from the Greek words "idon" and "teli" meaning "I perceive" and "from a distance" respectively.

4.2 Telidon Program Strategy

To put the Telidon Program R&D strategy in context, it should be noted that the British Prestel videotex system which evolved from work at the British Post Office, was viewed by the Post Office Telecommunications Department (British Telecom) as a technology that could potentially increase the use of the public telephone system in the off-peak non-business hours. It was being considered for field trials by the Bell System in Canada. Bell Canada viewed the technology as a means of "head-on" competition with cable television companies, utilizing telephone lines and competing for viewer time directly on the home TV set. Bell announced their trial of the British system two days after the DOC announcement of Canadian videotex.

The Telidon Program received $9 million funding in March 1979. Of the initial allocation, $4.1 million was for prototype development for Canadian videotex.[3] The activities supporting the R&D strategy at this time were "to develop, to pre-production status, those hardware and software components of the Telidon system required for immediate use in field trials to demonstrate the Telidon capabilities."[4]

It was also necessary to develop the Telidon "prototype" further. Home terminals, information provider terminals, an RF adapter, cable/off-air interfaces, and business terminals were listed as required hardware developments. Software was needed to develop

database content, systems host software (information retrieval and two way interaction), and telesoftware to support interactive databases.

Most of the development work was to be contracted out to the private sector and guided and assisted by the CRC. Some work for future enhancement to Telidon was also begun:[5]

- additions to the picture description instructions to permit manipulation of images for interactive dialogues between man and machine;
- demonstrations and field trials of Telidon over packet switching networks such as Bell Canada's X-25 DATAPAC and CN/CP's INFOSWITCH;
- re-initiate the dormant multi-terminal network between RMC, DREO, University of Manitoba/Manitoba Telephone and DOC/CRC to further develop, evaluate and field trial direct Telidon terminal-terminal interactions.

These enhancements were of a research and development nature.

Thus, the thrust was to produce both hardware and operational systems software for use in field trials. Their evolution would serve as a field trial, as experience was gained in the exploitation of Telidon in systems and services. Most of the work contracted out to the private sector in 1979/80 and 1980/81 (Table A-1) was for the development of Telidon software and databases along with various pieces of hardware.

4.3 Augmentation No. 1

One of the main aims of the R&D strategy was to reduce the cost of the Telidon terminal in order to be more competitive in international markets. Within the R&D of lower-cost Telidon equipment activity, the following developments were initiated:

- enhancements of the user terminals to incorporate new features and state-of-the-art developments in very large scale integration (VLSI);
- enhanced database software;
- full channel teletext broadcast system for TV cable network;
- interface with packet-switched data networks to reduce communications costs.

Since no additional person-years had been allocated to the Department for the program, the main burden of program management and the wide variety of associated project tasks had fallen on the research personnel who first developed Telidon and who were vital to its timely and continuing progress.[6] Consequently, some planned R&D for advanced Telidon enhancements was deferred because of manpower, funding, and time limitations.

4.4 Augmentation No. 2

The next major relevant Treasury Board (T.B.) submission was approved in July 1981, with a further augmentation of $7.8 million for FY 1981/82 and $16.3 million by FY 1982/83. The T.B. submission emphasized that prototype development was critical to the development of a Telidon industry.[7]

The CVCC Industrial Marketing Sub-Committee had been urging the volume manufacture of hardware and the development of the VLSI version of the terminal in order to reduce the price.[8] The Communications Research Advisory Board (CRAB) Report for 1980/81, although issued after the approval for new funding and new program activities, supported the higher production volume concept. CRAB also emphasizes that since "videotex is still an evolving technology...much more research will have to be done. [Research] activity related to Telidon must be continued and expanded, not only in DOC but in the private sector as well. For example, there needs to be a simplification in the access protocols so as not to overburden the user with complicated 'decision-trees' before gaining access to information."[9]

The R&D activities were therefore still focussed on prototype development, with emphasis being placed on low-cost hardware and support to on-going projects.

At this time, the bulk of Telidon R&D was being conducted in industry, guided by CRC, with government contracts providing the primary source of funds. The use of private industry as the predominant source of Telidon R&D funding was seen as "several years away when revenues generated by sales by the manufacturing and services parts of the industry are suitable for private R&D applications."[10]

4.5 Reallocation of Funds

Subsequent T.B. submissions dealt with transferring funds between votes to meet changing program needs. In November 1981, $5 million was approved for the CBC field trial.[11] The activity supporting the R&D strategy here was to field test and develop the videotext systems. The CBC field trial was to provide for the system design, completion of component development, manufacture and procurement, installation operation, and evaluation of two full working systems to learn what the teletext could do for the broadcast business and how a teletext system may be designed to fit the broadcasting environment.

The next T.B. submission with specific R&D relevance was approved in November 1982, transferring $450,000 from IISP to the series of R&D.

It was stated that during the past two years, the bulk of available funds had been used to assist industry to engineer and manufacture the products in short production runs of hardware, to adapt these components to a variety of operating systems (e.g. telephone, TV broadcast, and cable TV), and to resolve the problems which arose in integrating Telidon components into conventional telecommunications systems. Funds were also applied to reduce the cost of Telidon components by use of micro-electronic technology.

The R&D activities involved developmental aspects, database development, technical development, demonstration of system capabilities and content development in relation to hardware and software development. Because of the slowness of the Videotex standards negotiation process, T.B. approval was obtained in April 1983, to carryover $300,000 of FY 1982/83 to FY 1983/84 to continue development of a VLSI chip for Videotex by NORPAK.[13] The stabilization of requirements for Videotex was crucial to the finalization of chip development and such stabilization depended on resolution and agreement of the Videotex standard.

4.6 Telidon Exploitation

A T.B. submission approved the Telidon Exploitation Program (TEP) in June 1983, from April 1, 1983 to March 31, 1985.[14] Under TEP, DOC continued the R&D strategy of

assisting industry to remain at the forefront of the development and application of Telidon technology. A set of activities to be undertaken by DOC was designed to fill certain important product gaps in the current store of Canadian hardware and software, increase our ability to create content, to use Telidon as an effective means of expression, and to explore and develop several promising new next-generation embodiments of the Telidon principle.

The work carried out at the applied development end of the R&D spectrum, to ensure the early availability of marketable systems, was a greater priority than the more fundamental research and development.

The R&D strategy was now re-focussed on the following research projects (in addition to supporting on-going projects):

- enhanced and novel Telidon delivery techniques - including mobile Telidon applied to ships, aircraft, and automobiles; interactive Telidon or two-way cable; theoretical and experimental characterization of transmission media; development of error-correction schemes; and investigation of standards and protocols;

- terminal-to-terminal Telidon (Shared Visual Space) - including the provision for image manipulation and control and the development of higher-level interactive graphics languages and software tools;

- enhanced and augmented graphics capability - including: extension of presentation coding schemes to provide full photographic-style imaging, voice and sound, three- dimensional characteristics, and effective animation techniques;

- enhanced page creation capability - including: augmented graphics capabilities in page-creation machines, graphics creation and editing by voice recognition techniques; and extension of the use of VLSI micro-electronics on Telidon hardware components;

- behavioural research - including: effects of transmission errors and correction schemes, database retrieval techniques and languages; and understanding of graphics;

- evaluation of the social, economic and technical parameters of the Telidon program.

Development work on hardware products essentially involved "chasing the standard" over the last two years of the program. Although the North American Presentation Level Protocol Syntax (NAPLPS) standard had been announced in 1981, the additional protocol requirements to the standard reference model (SRM) level negotiated by AT&T meant that all Canadian-developed decoders had to be upgraded. Some of the leads achieved by Canadian producers were therefore eroded as retrofitting to SRM level of NAPLPS was carried out.

Also, over the last two years, the development of information content has received greater emphasis, particularly through the Content Development Program (CDP). The priority concern to the user now appears to be more the quality and usefulness of the information provided rather than the technology used to deliver the information. Although affordability of equipment remains a critical factor in realizing any cost-effective service, the growing awareness of soon-to-be affordable decoding equipment is lessening this concern.

References - Section 4

1. CPDL. A Short History of CPDL's involvement with TELIDON, pg.1.

2. Ibid.

3. TB763862 (Original Submission). Approved March 29, 1979. To support the Canadian services and manufacturers industry in exploiting Telidon.

4. Discussion Paper. Augmentation of the Telidon Program 1981/82 and 1982/83. January 20, 1981.

5. TB763862 p. 5.

6. TB773552. Approved October 16, 1980. Augmentation of the Telidon Program 1980/81 and allocation of 15 PYs.

7. Ibid p.2.

8. Ibid p.7.

9. TB777854. Approved July 16, 1981. Augmentation of the Telidon Program 1981/82 and 1982/83, and the allocation of 35 PYs.

10. Ibid.

11. Discussion Paper, January 20, 1981. p. 34-5.

12. Report of the Communications Research Advisory Board 1980-81. April 16, 1981. p. 16.

13. Discussion Paper. January 20, 1981. p. 39.

14. TB779457. Approved November 5, 1981. Funds for the CBC field trial, allocation of $1M from TB777854.

15. TB785133. Approved November 22, 1982. To transfer IISP funds from Contributions to Capital funds for the Telidon Exploitation Program.

5. TECHNOLOGY TRANSFER

Before discussing the actual technology transfer which took place in the Telidon program, it is important to acknowledge that the underlying technology had been developed at CRC between 1969 and 1979. Thus, while the underlying basic research had already been accomplished and some technology transfer begun with NORPAK, the Telidon program's expansion necessitated further research to develop a prototype. We will examine the transfer of Telidon technology and compare it with the transfer of Natal technology from NRC.

5.1 Telidon Technology Transfer

The Telidon research and development strategy contained two of the critical components for successful technology transfer. First, since the Telidon technology of CRC was the ultimate winner over the formidable competition represented by Prestel of the UK and Antiope of France for the North American Standard, it is clear that the scientists and researchers involved in the original research and its translation into effective prototypes were of a high calibre. Second, senior management was directly involved and committed to Telidon from the beginning of the program.

R&D projects carried out under the Telidon program were highly directed with clear statements of purpose, often in the area of development and sometimes research. No problems of non-delivery or late delivery were recorded in project files, or mentioned in the course of interviews. Virtually all projects under the Telidon R&D program were completed as expected and reports and equipment delivered. This is another critical characteristic for success in research and development: a very specific focus on prototypes which were readily translatable into marketable products.

In a discussion paper produced in 1982, DOC estimated that 19% of the Telidon R&D was done in-house, 74% by industry, and 7% in universities. In Part 3 of the 1983/84 Estimates, DOC indicated that in the Telidon area, the ratio of Private Sector Investment to Total Government Investment was 4 to 1 based on surveys undertaken. The total R&D effort of government is approximately $22 million of which DOC funded $15 million. If the ratio is indeed 4 to 1, then total Telidon R&D would be $110 million of which DOC funded 14%.

In most cases, when an R&D project was initiated, the people involved in the contracted project would work closely with CRC personnel to develop the product prototypes and/or software. This early private-sector affiliation and sharing was one of the major sources of technology transfer leading quickly to innovation in an emerging Videotex industry. Thus, the Telidon research and development strategy of involving the private sector directly and obtaining a significant commitment and investment from them was successful. Also, the technology transfer was further promoted by the migration of the private sector wishing to follow through and try their hand in developing this new inventory.

With respect to the equipment technology transfer, NORPAK was the lead company supported. Others, including Northern Telecom, Microtel Pacific Research and Electrohome were involved in the development and production of decoders. Electrohome is still involved and Microtel Pacific Research has spun off their Telidon activity to New Media Technologies. At the present time the first terminals having the capability and performance in accordance with the SRM of the NAPLPS standard are being produced.

The Videotext/Teletex industry is currently in a holding pattern largely due to economic pressures but also while awaiting the inevitable reduction in the high cost of the

decoders. The latter is not due to any failure of the technology or any question of the utility and viability of such services, but is due to two other factors. First, there was a substantial delay in fixing the requirements because of the slow process of reaching consensus and agreement on the North American Standard. This standard would assure universality and suitability for mass markets (although the negotiation process for Telidon was fast compared to normal standards development). Second, the process of producing low cost decoders depended on both cutting the component cost as well as gaining assured access to mass markets for the equipment.

The standards were necessary in order to ensure that equipment and systems would work in harmony with other systems and not become obsolete too quickly. While it took some time for the standard to be adopted, it is now possible for the Canadian Videotex Industry to become involved in the production and sale of decoders under that standard with reasonable assurance and opportunities to compete in North America and the Pacific Rim.

Beginning in late 1979 and early 1980, the software to operate "special purpose" host and related computers that made up other essential Telidon hardware components entered the technology transfer phase. There was a need to develop database software content, and management and delivery systems for both Videotex and teletext information; however, there were few systems analysts/programmers on staff at CRC. To develop the software, CRC contracted programmers and analysts to work on-site in the development of the software. In the process they became very knowledgeable in the area of Telidon software systems and data bases.

This brought about the transfer of technology and the creation of a Telidon software and consulting industry in Canada. This industry now enjoys a worldwide reputation and regularly exports its "products". A quick look through the Telidon Directory reveals the numerous software and system providers, many of whom were originally contracted by DOC in the first two years. Notable among them are firms such as Cableshare, Genesys, and Systemhouse. Thus an important component of the success of Telidon technology transfer was the significant transfer of researchers and contractor affiliates involved in Telidon in the private sector.

In short, the technology was transferred to industry in both hardware and software utilizing essentially the same two mechanisms:

- transferring people with knowledge; and
- contracting out extensively for both R&D and equipment purchases including prototypes.

In terms of the original evaluation questions concerning technology transfer, the research results were made available to those who wanted them. This was done mainly in the form of an apprenticeship and consultative interaction. From the time Telidon was announced up until the completion of the field trials, scientists were pressed into the service as demonstrators and troubleshooters in support of the developing industry and the users. As such, the R&D program fully supported the field trials and resolved the technical difficulties of introducing and interfacing the hardware, software, and systems. Transfer was successful, with the technology ready and available as necessary for transfer in both the hardware and software areas. One of the resultant benefits was the technical training which has been usefully and effectively applied to other product areas in related information industries such as education and training, office communications, and automation.

5.2 Natal and Telidon Technology Transfer

In this section, the highlights of Telidon technology transfer are examined in comparison with another similar technology and the way in which the latter was transferred.

Natal is basically an authoring language for computer aided learning, developed initially by the National Research Council (NRC), and subsequently transferred to Honeywell. A case study of that technology transfer is available from the Evaluation Branch of NRC (see reference 7). The two transfers are reviewed here in light of the model and factors identified in section three.

In both cases the motivation for technology transfer, was "technology push". In the case of Telidon, modification of that strategy depended on "market pull." Technology push is not seen by most authors as a viable means of promoting the transfer of such technology if it is not matched by interest from the market.

In the case of Natal there were problems with respect to the business plan and in the identification of the recipient (the market side of the initiative). Indeed, the subsequent targeting of Natal to different markets from those originally perceived by NRC (who saw the educational market as a primary client) was probably related to the late identification of a recipient firm and differences in understanding of the marketplace. As well, there was a problem in determining what product was to be promoted, whether it was the authoring language Natal itself or products which used it. This certainly delayed, if not inhibited, acceptance of a product.

In the case of Telidon, while it started as technology push, there was explicit recognition and resource allocation to promotion of the product in the identified market from the inception of the Telidon program in March 1979. While there were a number of different but consistent products including decoders, software, and content or data to be used together in one system, there was no confusion over what was to be marketed. The system and the component products promoted were extensive and diverse. As such, it required significant resources to implement, demonstrate, and keep up with the changes imposed as a result of changing field trial experience and standards. The net effect, however, was to substantially shorten the interval between the emergence of the technology and innovation from it.

Another contrast between the two transfers is in the area of consultation. Telidon program managers aggressively solicited industrial input through consultative committees who were central to the identification and promotion of new initiatives in the program. Natal solicited such input, but on a more limited scale, perhaps partly due to the difference in resourcing.

Both technologies used the avenue of procurement to promote the transfer of the technology. In both cases, terminals were obtained from the private sector as a means of transferring hardware technology. The prime beneficiary of this activity in the case of Telidon was NORPAK, and to a lesser extent, Northern Telecom, AEL Microtel, and Electrohome. In the case of Natal, however, it was initially more evenly distributed among a number of small firms but later it became concentrated in one multinational firm. In Telidon, the field of players continues to widen, each having found its own market niche.

With respect to the abilities of the recipient company to manage and utilize the technology, certainly for Natal the ultimate recipient, Honeywell, was in an excellent position

to do so. However, it decided not to enter the marketplace with the language at the level and in the way that NRC had originally envisioned. In the case of Telidon, a number of the companies involved were started in order to receive technology transfer. With some of the smaller companies, a lack of resources made it difficult for them to remain in the market during the hiatus in production while standards were finalized and costs of decoding were lowered.

With respect to the professional people involved in both projects, the readiness of the state of technology development and commitment and enthusiasm required for technology transfer was clearly evident. However, in the case of Natal, technical difficulties resulted in a delay in the development of the product. In contrast, the delays in the development of the Telidon product were associated with the marketplace and the dominance of the larger American firms in standards development, rather than primarily with the technical risks and difficulties.

In neither case would it appear that bureaucratic management by government officials inhibited technology transfer. Indeed, anecdotal examples abound in the Department of Communications of ways in which program managers acted in a significantly entrepreneurial fashion to move as quickly as possible to transfer technology. Other anecdotes indicate that a lack of business acumen and market dynamics may have been in some cases obstacles to the technology transfer. This, however, was never seen as a critical factor but simply as differences in perception of business needs and strategies between the firms and the government officials involved.

In both cases of technology transfer, it is clear that the ultimate expense for the transfer is, or will be, generally greater than originally anticipated. In the case of Telidon, approximately $15 million was spent on technology transfer including the budget revisions and additional funds where necessary. In the case of Natal, only about $2 million was spent on technology transfer and it is the view of those who undertook the case study that considerably more funds will be needed before technology transfer can be considered to be successful.

In the case of Telidon, technology has been successfully transferred and a substantial number of Canadian companies and Canada itself are benefiting as a result. In the case of Natal, the technology is ultimately transferable but requires more attention and resources on the part of both Honeywell and the government for the technology transfer to be successful.

6. COMPANIES SELECTED

This section of the report describes how companies were selected and what the consequences were of these decisions.

6.1 Hardware

In the area of hardware, the main firm was NORPAK. In December 1977, licenses for Interactive Visual Communications System (IVCS) and for Interactive Graphics Programming Language (IGPL) were issued to NORPAK by CPDL. NORPAK remains the sole Canadian licensee for Telidon hardware.

By the time Telidon became a development program, additional R&D contracts were given to Electrohome as a sub-licensee of NORPAK, and to Mitel to study the feasibility of using VLSI in Telidon with NORPAK. (Mitel was the only known Canadian producer of VLSI chips at the time. To this day, there are still no producers in Canada of VLSI chips in custom or programmable array form.)

Although DOC continued to support Electrohome through acquisition contracts, and by providing knowhow and assistance when they requested it, DOC did not provide major financial support to Electrohome's R&D efforts in Telidon. Electrohome preferred to derive its knowhow either independently or via its sublicense arrangement with NORPAK. Later, substantial direct R&D financial support was, and is, being provided to develop an advanced public access terminal.

In the case of Mitel, the initial VLSI feasibility study was completed. Mitel, intent on its own VLSI needs, showed no further interest in pursuing VLSI development for Telidon. NORPAK continued with VLSI development engineering on its own with DOC support.

Whether the sole sourcing of NORPAK represented a conscious government decision to use a chosen instrument or not is irrelevant. The videotex and teletext technologies had matured and were being exploited worldwide. An acutely competitive race developed between the UK and France. The long range prize to be won would be the USA market. The UK and French technologies were seen as inferior to the DOC-developed technologies; but time and expertise were the keys to winning a place for Canada in these new technologies. Therefore necessity dictated that early and substantial support be provided to NORPAK in the development and production of decoders for the field trial evaluation of both market and system needs. There has never been a situation where any company has been given exclusive government assistance in the case of Telidon in bringing the technology into commercial operation. However, the transfer of Telidon decoder hardware technology to the private sector had to be essentially focused on NORPAK in order to be competitive. Had it been otherwise, much greater funding and delay would have been likely, and the race lost.

In the search for a low cost terminal, NORPAK introduced its first VLSI chip, the colour video display generator (CVDG) chip, in September 1984. Reducing component density and assembly cost is the first step toward affordable Videotex/Teletext terminals. Developed and engineered by Norpak for DOC and fabricated by Rockwell International for Norpak, this advanced state-of-the-art chip will cut the manufacturing cost of videotex decoders sharply. Further cost reduction will result from the Teletext VLSI chipset developed by Norpak together with Samsung Electronics Company Limited of Korea and National Semiconductor Corporation for the DOC. This is a two chip addition to the first chip

developed to convert a videotex decoder into a teletext decoder. Norpak will receive royalties on all the chips sold and get all related Videotex/teletext engineering for ten years.

In January 1985, another step occurred. NORPAK arranged with Samsung Electronics Company Limited to engineer and supply the North American and Pacific Rim Markets with consumer Videotex and Teletxt equipment through Samsung's established market access, distribution channels, and its marketing knowhow and power. NORPAK now has access to television consumers and the manufacturing capability needed to succeed in what is really an already dominated silicon commodity market where sand is literally manufactured into chips and television tubes on a massive scale far beyond the product capabilities and capacities of Canadian enterprise. Thus, NORPAK will not manufacture the chips or the terminals as these are, like the TVs, commodities for marketing purposes and require too costly an infrastructure to access and manufacture. NORPAK's products will be in the specialty engineering area of picture creation systems, teletext delivery and other systems benefitting from the exploitation of Telidon technology such as in office automation.

6.2 Software

In the area of software, more companies were involved in the systems and data-base R&D effort. CPDL controlled the software licensing.

As of January 10, 1985, royalty-bearing licenses on the Telidon data-base software (case 7128) have been granted to:

British Columbia Telephone
Infomart
New Brunswick Telephone
Bell Canada
Alberta Government Telephone
Saskatchewan Telephone
Genesys

Royalty-free licenses on the Telidon data-base software have been granted to:

University of Montreal
University of Waterloo
Environment Canada (AES)
Department of National Defence (DND)
Clinical Research Institute of Montreal (CRIM)
University of Prince Edward Island
Red River Community College
National Museums of Canada
College d'Enseignement General et Professional d'Alma (CEGEP)
Sheridon College of Applied Arts and Technology
Brock University

In the first two years of the program, software R&D contracts were given to Genesys, Miller Communications, Norpak, Quasar Data Systems, Sharon Professional Services and Systemhouse.

The basis of selection of these firms, according to CRC documents, was as follows:

"For contract selection, use will be made of the DSS competitive standing offer agreement. Source of supply will be Genesys, Sharon Professional Services and Systemhouse depending upon the capability and experience of the personnel made available. The selection of the contractor will be done on the basis of their expertise in the required areas of Telidon software development and the company's potential for achieving cost-effectiveness, efficiency with a minimum of learning time for the contract employees."

The statement of work for the standing offer reads as follows:

"Work is required to support the development of software and documentation related to the continuing development of the Canadian videotex system, Telidon. Specifically the following tasks have been identified:

1. Software to communicate with Telidon user terminals, to receive messages, interpret them and request pages from the data base. Status of each terminal attached must be kept.

   - Software to support logon and logoff procedures and error message handling.

   - Software to provide a system monitor and recovery facility.

2. Software to provide a message store and forward facility.

   - Software to provide an action page capability with two application programs.

   - Software to provide a teleshopping capability.

3. Software to provide a data base reorganization, restructuring, back-up and recovery procedure.

4. Software to provide a statistics gathering capability."

6.3 Other

One major R&D project falls into both the categories of hardware and software, that of Telecable Videotron.

The first phase of the project was done under the auspices of the PILP/COPI program in FY 1978/79 at the time the Telidon program was not yet approved. The program was completed in March 1979. It showed the possibility of transmitting NTSC pictures created at a remote location (Ecole Polytechnique). After the images were injected in the network, the quality of the signal after a different number of amplifiers was measured. The quality of the image for different television vintages was also studied. The results of the experiment were very useful and this information was made available to both DOC and NORPAK.

The second phase proposed setting up a computer in the head end where it could be connected to remote data bases (La Presse, CRC, etc...). An important objective of the project was to develop software which would permit the computer to interrogate remote data bases, retrieve information and forward it to the viewer.

The proposal was accepted because

"Telidon services must be available in all three modes. The contribution of this contract will be a solution to one major distribution mode."

6.4 Summary of Company Selection

Sections 6.1, 6.2 and 6.3 identified which companies were selected in order to accomplish the technology transfer of the Telidon research and development. With respect to hardware, it is clear that the selection process was based on the capability of firm to adapt and develop the technology and to transfer it into a marketable product. The focus was on Canadian firms who were willing to work closely with CRC to further develop the technology. As a result, prototypes were developed which were better than either Prestel or Antiope. These became the North American standard for Videotext.

In the area of software, many firms were involved because of the professional competence of individuals within the firms, and their ability to develop the necessary Telidon software. The transfer of software could be more dispersed because major capital investment was not necessary, as was the case with the technology transfer of hardware. As a result of involving the private sector, Canada now has a significant software industry which consults internationally and is a source of continuing development with respect to Telidon.

As a result of the selection of the companies in hardware, NORPAK and Samsung Electronics together are ready to produce Telidon decoders, and are involved directly in that production. With respect to software, there is a major Canadian videotext software and consulting industry with an international marketplace and a worldwide reputation.

7. RESEARCH AND DEVELOPMENT RESULTS

We will briefly review the results of research and development activities and of its transfer in the areas of hardware and software.

7.1 Hardware

Development work related to Telidon hardware will continue. Terminals having the capability to perform in accordance with the SRM of the NAPLPS standard have been produced. Terminals with greater resolution and performance beyond SRM are already under development by Electrohome and others. The North American Videotex/Teletext industry, currently in a holding pattern due to both economic pressures as well as a lack of readily-available low cost decoders, is slowly recovering. Evidence is mounting in the USA that there are low cost decoders on the way via NORPAK and Samsung. As has already been documented, NORPAK introduced its colour display generator VLSI chip in September 1984 and its teletext chipset in November 1985. In January 1985, NORPAK arranged with Samsung Electronics Company Limited to engineer and supply the huge North American and Pacific Rim television converter and television set market with consumer Videotex and Teletext equipment, using NORPAK's videotex/ teletext engineering leadership and expertise. NORPAK's in-house products will be primarily in the area of picture creation systems, teletext delivery, and related systems. In commercial and public access information systems, decoders with higher resolution and colour selection in excess of SRM are under development by Canadian companies such as Electrohome and New Media Technology.

7.2 Software

As has been documented, there was a need for considerable software development to support Telidon hardware. CRC management contracted with programmers and analysts to work closely with them in the development of this software. As a result, there was a transfer of the Telidon R&D through the creation of a software and consulting industry in Canada, including videotex/teletext database management and information providing systems operation.

7.3 Summary of Research and Development Results

The research results were made available to anyone who wanted them. To expedite and maximize the diffusion of the technology to Canadian entrepreneurs, the transfer of technology occured generally through direct contact, largely in the form of apprenticeship and consultive interaction. The most effective transfer of technology to industry was in the early phases of software development through the transfer of people. Later, new hardware technology was transfered in a similar manner.

Problems identified by users in the industry were solved through the assignment of scientists and engineers from CRC. These people were pressed into service as demonstrators and troubleshooters in the support of the developing industry and users. Thus, the R&D program fully supported the field trials in resolving technical difficulties related to the introduction and interfacing of the hardware and software systems.

One spinoff of the program was technical training which has been beneficial in the development of other product areas in videotex, teletext and related information industries.

8. SUMMARY AND CONCLUSIONS

The purpose of this study was to assess the contribution made by the research and development activities of the Telidon program. The study concentrated on the process by which Telidon technology was transferred to the private sector and the continued role that R&D played in the establishment of commercial Telidon products.

The R&D strategy of the Telidon program was to develop prototypes for use in field trials in response to competition for demonstration of videotex systems. Throughout the program, the Telidon R&D strategy involved:

- support of field trials experimentation with evolving prototypes in hardware and software; and,
- work toward lowering hardware costs through technological and business innovation.

This strategy was consistent with the overall program objective and remained essentially unchanged throughout the program. Clearly, the R&D strategy and the program R&D activities were linked to the overall Telidon objective of fostering the development of a Canadian videotex and teletext industry.

The first priority was to develop hardware, content, and system software which produce operational systems for telephone, broadcast, and cable transmission. The second priority was to develop low cost hardware through both VLSI microcomponent technology and mass production for mass audience. The exploitation program from 1983-85 continued to develop prototypes and also continued basic research on videotext and teletext enhancements. Thus, the research and development strategy to initially develop an application of the technology remained constant throughout the program, but adapted itself to an evolving environment through a series of activities identified above. The translation of the strategy into activities evolved in response to changes in the market, and resulted in its eventual adoption as a North American standard in videotext in modified form.

The research and development strategy was supported by excellent scientists and engineers and received strong support from senior management throughout the Department of Communications. The DOC-funded research projects were completed on time and estimates are that approximately 25% of the research and development on Telidon was funded by DOC.

The technology of Telidon developed at CRC was transferred into the private sector. In the case of the hardware, while a number of companies are involved, the principal one, NORPAK, is now actively involved in engineering and supplying the North American market with consumer videotext and teletext equipment through Samsung's established mass marketing and distribution channels. It has access to the mass television market and manufactures using the DOC/NORPAK-developed VLSI chips. While NORPAK will not mass manufacture the chips and terminals, it will continue to develop related system products in such areas as picture creation systems and teletext delivery systems. Electrohome and New Media Technology (the latter spunoff from Microtel Pacific Research) continues to develop and produce hardware decoders for the commercial and public access Kiosk markets (e.g. Teleguide).

Software technology was also transferred, primarily through the transfer of people to the private sector, and also through CRC's extensive contracting to develop the software. In the process these persons became very knowledgable in the area of Telidon software systems and data bases. As a result, there was the creation of a Telidon software and consulting industry in Canada. This industry enjoys a worldwide reputation and regularly exports its products.

The technology transfer has been extremely successful, particularly in comparison with other government efforts at transferring technology to the private sector (for example, the National Research Council and NATAL). While the Telidon program had considerably more funding, its initial research strategy and the adaptation of activities dependent upon problems encountered ensured its eventual success in being transferred to the private sector.

Throughout the Telidon program the research results were made available to anyone who wanted them. Technology transfer was generally through direct contact. Problems which were identified by users in the industry were solved through the assignment of scientists from CRC. The R&D program therefore fully supported the field trials and resolved technical difficulties related to the introduction and interfacing of the systems. One of the beneficial spinoffs which occurred was the development of a trained cadre of persons in electronics as a part of the Canadian Electronics Industry.

In summary, this review concludes that the research and development activity was plausibly linked to the goals of the Telidon program. The strategy, as developed, was to support the field trial experimentation with evolving prototypes and to work toward lowering hardware costs through innovation. The R&D effort which involved development of prototypes and transfer of expertise and knowledge to companies did contribute to the development of the videotex industry. Important elements of this process included contracting out, the timely availability of research and development products, and the transfer of people to the private sector.

While it is not possible to answer all of the evaluation issues with the precision one would like, the available evidence supports the conclusion that the research and development component of the Telidon program effectively contributed to the development of a Canadian videotex industry.

APPENDIX A

TELIDON R&D PROJECTS

In order to trace the R&D efforts undertaken by DOC under the Telidon program, we attempted to develop from the departmental data base, a list of all R&D projects funded by the department. We were unsuccessful in obtaining a complete list but were able to identify most of the projects. Tables A.2 to A.5 summarize what various sources said were the R&D expenditures made under the Telidon program. Table A.6 list all contracts to NORPAK.

The project number used for Product R&D between 1979 and 983 was 15207. A list of 15207 projects for 1979/80 and 1980/81 was developed. This project list and other available project information, acquired by reviewing project files at headquarters and at CRC, was used in our analysis.

With respect to other government departments, the amount of funding directly related to Telidon is not always identifiable because of differences in the way programs are structured and the way information was collected by these departments.

The basic information available is contained in Appendix A.

1. Telidon R&D in the First Two Years

For purposes of this discussion, project and contract are used interchangeably.

Generally speaking, based on the list of contracts for 1979/80 and 1980/81, we found that there were five types of R&D contracts as follows.

Purchases of Equipment: Since they were actively engaged in an R&D program, CRC required a good deal of equipment. Much of the equipment could be ordered off-the-shelf from catalogues. In our review of the contract files, we found that for the R&D projects listed for the first two years, the contracts to hardware suppliers were for items to be used in the R&D effort. Some involved R&D as well by the supplying company:

- NORPAK - about 75% of the contracts involved R&D by the company
- Electrohome - 75% of contracts involved R&D to improve monitor performance
- Mitel - feasibility of developing VLSI chip.

The equipment purchase contracts or projects then were related to the R&D objectives and strategy.

Software Development: The software and systems development contracts and projects are perhaps the most interesting area of Telidon R&D.

In the first two years, of eleven contractors who provided software and data base support, eight provided the support in the form of personnel who worked at CRC alongside the scientists and engineers who had developed Telidon.

Because of the R&D nature of the work most of the contracts reviewed did not have a product specified but instead, had work statements defining the work to be done and the objectives. Renewal contracts, by implication, continued the basic R&D work defined by prior contracts. They specified that people, individually named, should be available to support the R&D effort. This software and systems R&D was required to support the field trials as part of the R&D strategy.

Hardware Development: In the first two years of the Telidon program there were 42 contracts to hardware suppliers under project 15207. Of these, Norpak got 24. According to Norpak records, about half of these were directly for hardware development, with the remainder being for equipment requiring no immediate R&D, but were to be used in R&D for retrofitting and maintenance of equipment.

Of the remaining contracts to equipment suppliers, 2 involved direct R&D on the part of the suppliers.

- Electrohome made modifications to its 3C-46* monitor to improve performance of future models and access to the RGB guns of the CRT for the Telidon decoders.

- Mitel investigated the feasibility and the resource requirements for VLSI development.

Clearly, these contracts related to the overall Telidon R&D strategy of developing hardware and making innovations to keep it current for purposes of the field trials. The Mitel contract was the initial step in the quest for lower costs through VLSI technology.

Cable Companies: The project list for the first two years reveals that there were two cable companies who received contracts for R&D. Cable Systems Engineering got a contract to undertake a broadcast field trial under* the R&D program. After a number of reorganizations, spin-offs, etc. involving Rogers, this became Cableshare - one of today's very successful small companies.

Telecable Videotron got a contract to do systems R&D to develop software to control two-way cable.

Other Contracts: In the list of contracts for the first two years specifically identified as R&D contracts was the University of Waterloo who received a contract to carry out R&D work complementary to the work CRC was doing in the software area. An individual received a contract to design a character set for Telidon. Part of this work was also being done under the Behavioral Research Program.

In summary then, according to DOC's available list of R&D contracts for the first two years of Telidon, 27 contractors provided R&D services to DOC. Of these, all were doing R&D type activities either directly or indirectly to support CRC's R&D.

The project list however, is incomplete as a record of the R&D results. For example:

- The project list accounts for $1.43 million in 1979/80 and $1.3 million in 1980/81 whereas other department data indicate these figures to be $1.63 Million and $2.13 million respectively.

- During this period field trials absorbed about $2.75 million, much of which could be classified as systems R&D.

- WETA cost $125K much of which involved modifying equipment on the spot and ultimately recalibrating the station's transmitter.

- Behavioral research was ongoing but does not appear as part of the Telidon program until 1981/82.

2. Beyond the First Two Years

Beyond the first two years of the program, we must rely on aggregate figures since little information was available from the project list.

A review of contract files at headquarters and at CRC however, revealed that the pattern of R&D contracts was similar to the first years of the program except that systems and software R&D efforts began to decrease, and Norpak was the only recipient of hardware R&D funds.

3. Behavioral R&D

Like the R&D effort in hardware and software, behavioral R&D began when Telidon was still the New Home and Business Services Program. Unlike the more glamorous hardware/software area however, it did not receive the level of attention or funding and was not initially identified as part of the program. As well, unlike product and software R&D which had a definable end product or involved person days, behavioral R&D has remained at a fairly steady level of effort prior to and since the beginning of Telidon and has continued to address the same subject areas.

Behavioral Research funded under Telidon was done principly by academics under contract to the department. The results of the studies were published by DOC in a number of Behavioral Research Publications:

No. 1 Telidon Behavioral Research
No. 2 Tree Structures
No. 3 Graphics
No. 4 Keypad Design
No. 5 Query Languages
No. 6 Information Retrieval

These publications have received wide distribution. Several thousand copies of each are in circulation. They have had direct impact on such aspects of the product as:

- keyboard design
- screen content design
- character sets
- graphics/character mix

4. University Research Program

Each year, the department sets aside an amount of money ($737,000 in 83/84 and $800,000 in 84/85) to fund research projects at universities. Some of these projects are related to teletext or videotex areas and as such can be classified as Telidon R&D.

Examples of projects which have been funded are:

- Visual performance measures of videotext viewing conditions.
- User Responsive Teletext.

In 1983/84, three projects related to Telidon were undertaken at a cost of $53,000. In 1984/85, two projects were undertaken at a cost of $40,000.

The project funds provided are in the nature of a grant. The program is not regarded as a main-stream R&D program for Telidon but clearly supports the overall R&D strategy.

5. Other Departments' Programs

There were and are a number of sources for funding of Telidon R&D type activities other than the Telidon program. These are:

- Program for Industry/Laboratory Projects (PILP) of the National Research Council.
- Enterprise Development Program (EDP) which became Regional Development Incentive (RDI) Program of Regional Industrial Expansion.
- Unsolicited Projects Program of Supply and Services.
- Research Grants Program of Natural Sciences and Engineering Research Council.

PILP Projects:

According to departmental records, the following PILP projects were Telidon related:

Company	Date	Title	Amount ($000)
NORPAK Corp. Ottawa, Ontario	Oct. 84	Development of Low-Cost VLSI-based, In-set Tele-text Decoder Module	$270
NORPAK Corp. Ottawa, Ontario	May 84	Development of NAPLS/NABTS-Compliant Professional Teletext Decoder	87
Videotron Communications Inc.,	Dec. 81	Developpement et evaluation du prototype de l'interface Montreal de l'abonne pour le systeme d'information a domicile.	750
Futurtex Communications Inc., Montreal	Nov. 83	Integration of Canadian Videotext Technology with the Printing Industry	409.5
Telecable Videotron Montreal	Jan. 80	La mise au point d'un systeme bilateral de television par cable capable d'acheminer l'information abonne sur demande	561
			2,078

EDP/RDI Projects:

The orientation of the innovation assistance aspects of the EDP/RDI Program is to provide contributions to selected companies for projects concerned with the development of new or improved products or processes or service capabilities incorporating an advance in technology and offering good prospects for profitable commercial exploitation.

According to available records, the following projects were undertaken under the program:

- NORPAK; Exploitation of Telidon technology, $1,718,980
- Videoway; Exploitation of teletext technology, $2,500,000

In both cases, the project was related to product development from the prototype to a full production model and as such was consistent with the overall R&D strategy.

Research Grants Program

NSERC grants support research programs in the natural sciences and engineering conducted by academic staff members of Canadian universities. Evaluation Branch personnel at DOC identified 15 Telidon related projects for a total of $500,000.