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Canadian
Computer/Communications
Task Force

Background
Papers

2 Peel County Pilot Education System

3 Computer/Communications Activities at Canadian Universities

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Richardson Lyman

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Background Paper

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The Canadian Computer/Communications Task Force

Background Papers

2 Peel County Pilot Education System

(A Processing System Covering Administrative Functions for the Peel County Board of Education)

Prepared by:

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Toronto, Ontario

January, 1972

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Foreword

Information systems are not new to education, particularly in such applications as student scheduling, accounting services, inventory and some computer-assisted instruction. Very little has been done, however, in the application of on-line systems in the area of administration, such as the maintenance of student and staff records, attendance keeping, enrolment and student testing where applicable. These are costly operations from a financial viewpoint, because of the amount of time the teachers and office staff have to spend on these purely mechanical procedures. Fortunately, it is in just such areas that on-line systems become cost effective because of the type of work and its repetitive nature.

The Pilot-System in Peel County puts the computer part of the office activity on the same level as the telephones, typewriters, the public address system, etc. This is achieved through the use of terminals. Both communications and transaction-oriented terminals are used in the system in a way that the merits of each may be assessed, using the work to be done as a reference. Operation of the system has clearly indicated that both types of terminals are required, but for very different tasks. The objective of the system is to make evident the effect upon the environment of instant access to a data base of which the credibility has been improved through computer control.

The system is presently in operation and assessments are being made of its effectiveness. Early indication is that rapid communications and automatic processing have a major effect upon the educational environment and can lead to much improved operations. For example, the scheduling of tasks for the computer is not required, nor are pending files. The computer system operating staff may be reduced to only a few people. There is a convergence of teaching and testing of students and widespread acceptance by the students in the obtaining of their results at the completion of their test.

Systems of this type are not yet within the frame of reference of the ordinary user and an accumulation of operational experience is required before the total implication can be more fully assessed. In addition, systems that operate in step with the administrative and teaching functions are easier and appear to be less expensive than traditional methods.

I would also like to take this opportunity to extend my particular thanks to the Canadian Computer/Communications Task Force, for their awareness of pilot-systems in this area of application, and the many contributions they made to the Peel County project. I must further express my appreciation of the generous contributions made by the following organizations: Bell Canada for providing the communications network and terminals; Consumers' Computer Limited, for the use of their computer; T-Scan Limited for the transaction terminal and system development; and the Peel County Board of Education, for providing the environment within which the system could operate.

Introduction

Education is a major social field, with boundaries that are difficult to define. Governments, both provincial and federal, regard it with growing concern, particularly because of the increasing proportion of government funds required to sustain a level of education equal or superior to that in other parts of the world. The future possibilities for Canadians are considered by many to exceed most countries.

The total subject-matter of education is very large; however, it may be conveniently divided into three components, as follows:

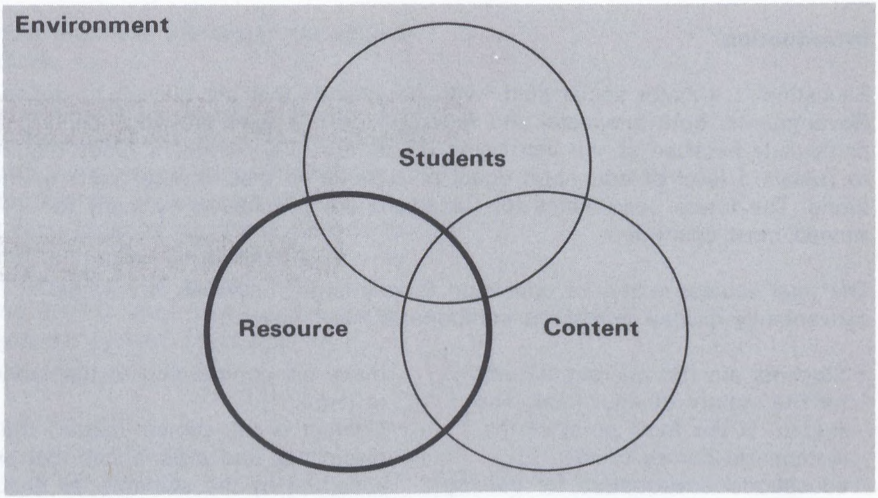
- *Students* are the operational unit for the system of education. The student is the focal point of the system. He comes to the educational environment for training and instruction, and then returns to the social environment in order to make his contribution to the world at large.
- *Content* is the subject-matter, the disciplines and experiences that are accepted by the students, to enable them to make decisions and effectively contribute to society.
- *Resource*, which includes the teachers, classrooms, equipment, supplies and administration that are necessary to present the CONTENT in a satisfactory manner.

The need for well-designed, direct-access information networks in the educational system is apparent, from both an administrative and a cost viewpoint, and the purpose of the Pilot-System is to illustrate that this can be accomplished with modern technology and at favourable cost.

The three components within the environment are shown in Diagram 1. The rectangular area surrounding the major components is the environment

The Pilot-System described in this report deals mainly with the RESOURCE of education. Its area of application is in administrative functions. NO considerations have been given to CONTENT, other than the interaction that reduces the administrative distractions of the teaching staff to allow them more time for teaching. The objective is to explore the use of modern methods of information processing, in order to improve operations and reduce cost.

Diagram 1
The Total Educational System



1. The Need for Education Systems

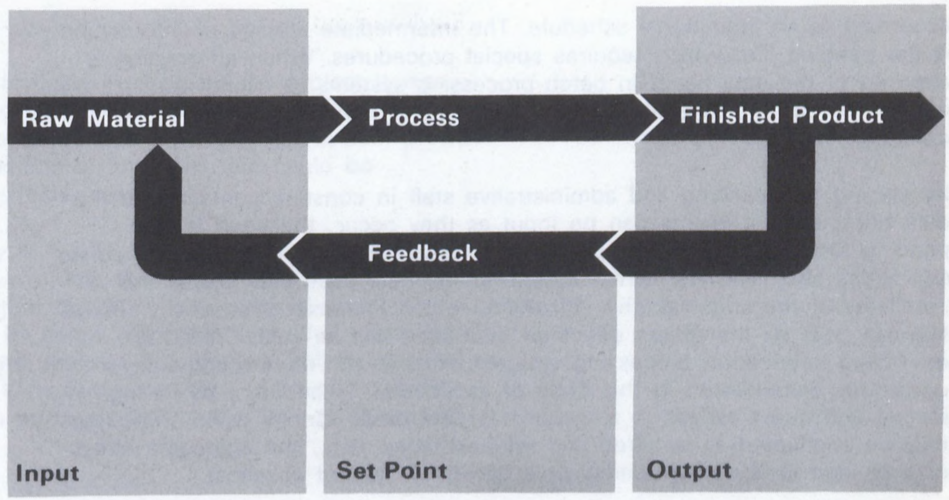
Industrial activities, when viewed as a system, are characterized by an input of raw materials, an operational process to which they are subjected, and an output called a finished product. This may be illustrated by Diagram 2.

Feedback is the regulation of input, according to output capabilities. The set point is the reference input to the entire operation, such as the rules of operation and the objectives.

The education system may be viewed in a similar manner. The raw material input is the children who become students during the period they are absorbing the content of education. The output is people who are capable of making decisions and contributing to society. The set point is the objectives and standards of education.

There are very great differences, however, between the industrial process and

Diagram 2



the educational process. In industry, the process cycle is very short. In the educational process, the cycle may last sixteen or more years. The operational unit of education (the student) is an unique and dynamic identity that cannot be grossed as can the units of industry. Students are continually developing and changing. Constant attention is required to keep up with new needs and demands.

These facts indicate that education carries an administrative and record-keeping burden which exceeds that of most other organizations. Since teachers are the instrument of education, some of this burden must also be carried by them. Such activities as absence reports, keeping of records, report card production, test marking, etc. are tasks which are generally classified as administrative distraction.

The data base of education is largely student and staff records. These records are changing constantly. Traditional batch-processing allows data to accumulate so that it can be run through a computer in bulk form and according to an operational schedule. The intermediate storage of information is the pending file, which requires special procedures. When information is required of the data base, in batch-processing systems, it cannot be considered current. This uncertainty is difficult to minimize and expensive in operation.

By placing the teaching and administrative staff in constant contact with the data base, so that events can be input as they occur, the need for the pending file and intermediate procedures disappears. The cost of intermediate operations also vanishes. Direct access to the data base also proves the credibility of the administrative operation, which increases productivity. These features have an immediate effect on education and its cost. Computer-controlled information processing systems excel in the routine and simple operations encountered in this class of application. In addition, by having instant and direct access to a responsive data base, various types of analyses may be conducted as required and without delay (*e.g.*, the aggregate effect of a change in teaching salaries or a survey of student absence).

2. The Pilot-Project

The Pilot-Project described in this report is the co-operative result of the organizations listed below:

- Canadian Computer/Communications Task Force of the Federal Department of Communications, which contributed funds.
- Bell Canada — for the contribution of circuits and equipment to move information between the computer and the operational centres.
- Consumers' Computer Limited — for the contribution of the central computing facility for the Pilot-System. This involved computer time for system development, as well as the processing and storage for the operational information.
- T-Scan Limited — for the development and co-ordination of the project and the contribution of transaction terminals.
- Peel County Board of Education — for the operational environment of the system.

3. Approach

With the financial contribution and facilities available to the project it was considered that a Pilot-System could be developed that would provide useful experience to educational administration. In addition, the Pilot-System provides a base to assess the efficiency of additional functions that could be incorporated, as well as their cost effectiveness.

The project commenced in February of 1971 with the objective of starting an operation during April which would run until the end of July, 1971. Whether the operation could be achieved within the time-frame desired was considered of marginal importance. Its accomplishment depended upon the success of parallel operations and the absence of unforseen difficulties. To expedite development, the software was sub-contracted to an organization which had previous experience with terminals and in the type of computer used.

4. Initial Situation

The fact that both staff and student records had already been implemented within the educational system was considered advantageous. These applications were:

- Staff Information System – carrying pertinent information on all personnel. This file is used for payroll and is processed in Ottawa.
- Student Information System – carrying information on students within the county. This was discontinued prior to the Pilot-System, but was considered useful for the data structure and content, as well as for the students who were still active in the chosen secondary school.

At meetings with the staff of the Board Office and the secondary school, the information to be used from within these records was agreed upon, as well as new information which would be incorporated into the Pilot-System. Examination of the existing records revealed that data was stored inefficiently and that it could be compressed by about 50 percent for the Pilot-System.

5. Operational Functions and Data

The operating functions for the system are based upon the information stored and its manipulation. There are two classes of records, as follows:

Type of File	*Size*	*Fields*	*No. of Files (approx.)*
Staff	650	151	6,000
Student	452	109	1,250

The contents of each file were examined by item with the user and the most important data selected for use by transaction card. For each file this amounted to:

Type of File	*Data Retrieval Fields*
Staff	39
Student	25

Each field is accessible through the transaction card and the results printed as requested, according to the sequence by which they appear on the cards.

Grouped information was also considered and the cards printed accordingly. This function would allow certain groups of fields within the file to be printed as a report. However, time and resources did not permit this to be implemented.

During the structuring of the system, the desirability of programs for scanning a sequence of records within the Staff and Student System was expressed by the user. These programs would enable such cumulative data to be retrieved as the number of people earning a specific salary, the effect of a general salary increase, the number of a given category of students, etc. The value of these types of programs was acknowledged, but it was not possible to develop them, due to limitations of both time and money.

The data fields which were not implemented on the Staff and Student retrieval cards (the numeric fields) are accessible by means of the update card. Since these fields were considered to be less frequently used, it was decided that they would be inconvenient for Pilot-System operation.

Student absence recording accounts for about half of the student record storage layout. The administering of absence records within the school is a difficult and expensive task when it is carried out manually. Therefore, the recording of absence was incorporated in the simplest way as a means of illustrating how this could be done in a fully implemented system.

Student testing is also mechanized in an elementary way. The purpose of this is to show how quickly a multiple-choice test can be marked and the administrative time that is saved for the teacher. It was recognized that this type of testing is not universally applicable. However, where it does apply, work simplification and reduced costs should result.

Modification of records is achieved by means of the Update Card. This card enables any field of any record to be updated (modified) as a simple transaction. Updating is also possible by teletype. In order to make a comparison, updating may be done either by teletype or by transaction.

Computation is carried out in only two of the functions described:

- Attendance Card — where the attendance record is incremented.
- Test Card — where the results are calculated.

6. Summary of System Operations

Input Data	*Field Retrieval*	*Field Modification*	*Computation*
Student Card	x		
Staff Card	x		
Attendance Card	x	x	x
Test Card	x		x
Update Card	x	x	
Teletype	x	x	

A description of applications and method of operation are covered in the Appendix.

7. The Physical System

The equipment content of the system is as follows:

Processor:

- IBM 360/65
- Core Store 1 million Bytes
- Disk Files 2314 or equivalent
- Magnetic Tapes
- Data Circuit Controller 2701/1270
- Type 2 Adaptor
- Line Printer

Communications:

- Teletype 10 Char./Sec.
- ASCII Code
- Asynchronous
- Switched Network

Terminal Equipment:

- 2 — Model 33 PSR TELETYPE Terminals
- Dial Up Operation
- 2 Data Terminals
  1200 Bits per second
  Asynchronous ASCII Code

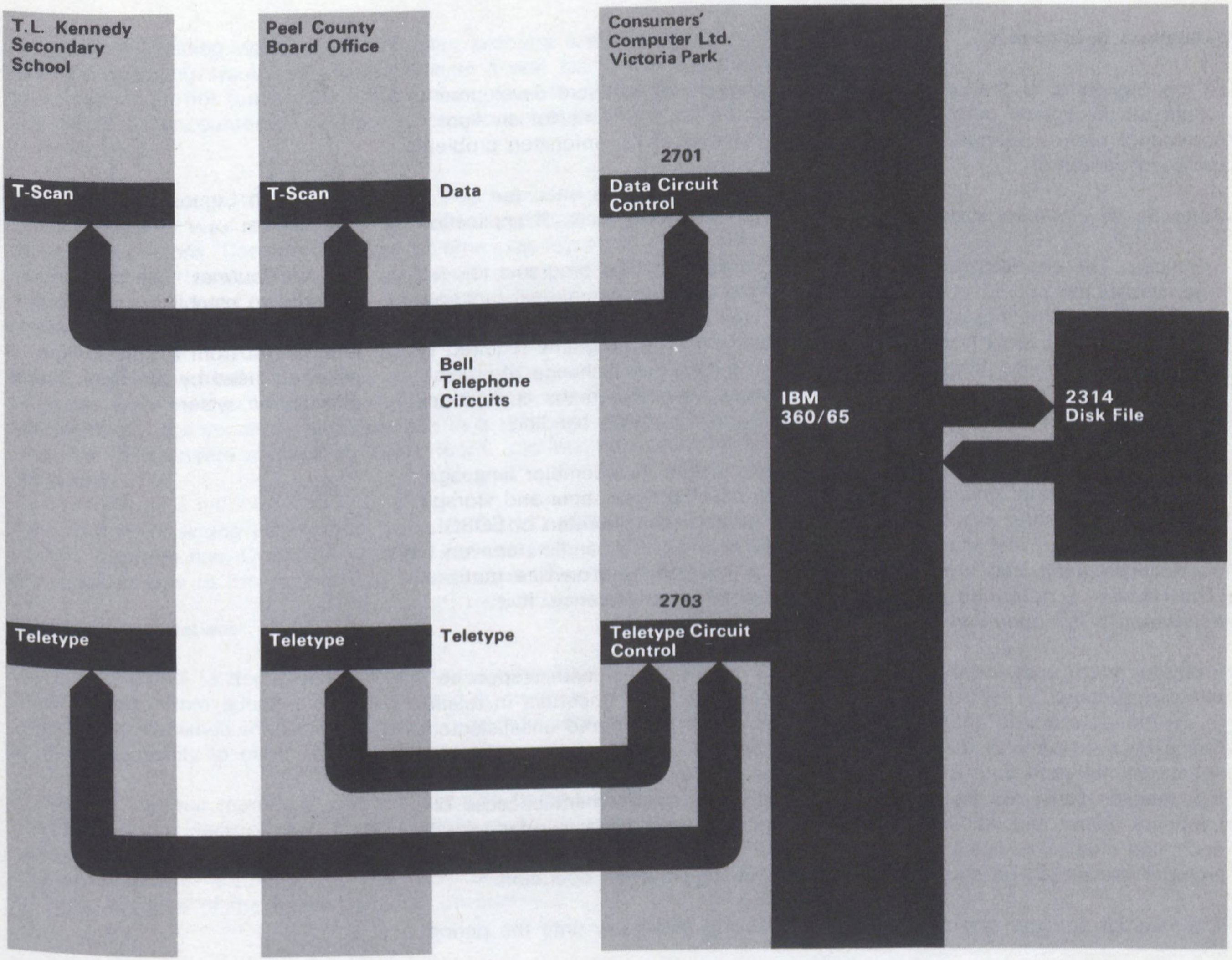
202C Modem RTS 65MS

The operational programs are loaded in each school day and operate from approximately 0830 to 1500 hours. A block schematic diagram (Diagram 3) of the system is shown below.

Operation of the computer system is OS MVT with a basic user partition of 66K bytes.

The transaction terminals are unique, insofar as the input message is an information matrix which is compressed and super-imposed onto ASCII characters for transmission. Reply to a transaction is standard ASCII code. The message structure and operational method is covered in the Appendix.

Diagram 3
The Peel County System



8. Software Development

At the beginning of the project it was recognized that software development would be the critical path and completion of the work in time for an April commencement of operation could only be achieved if no unforseen problems were encountered.

Software development divided logically into the following areas of application.

- *Handler*: The control program to administer the polling of transaction terminals and the messages that move back and forth from the computer. A similar program was also required for teletype operations.
- *Applications*: The programs to implement the operational function of the system.
- *Interface*: The programs required to administer the exchange of messages between the applications programs and the handler.
- *Service Routines*: The programs required to establish the record layouts of the system and extract information from magnetic tape as presently used by the Peel County information system.

The Handler and the Interface programs were written in assembler language to produce the most efficient operation in terms of process time and storage space. All application programs and service routines were written in COBOL. The software team consisted of three people, one on the handler, one on the interface programs and one on the application programs and service routines. (The Handler is described as part of the project for convenience. It is necessary to the operation but is part of another project.)

Problems were experienced at the beginning of the project with respect to teletype operation. The delivery of a teletype adaptor was uncertain in relation to the timing required and supporting software was considered unsatisfactory. The early decision was therefore not to concentrate on teletype operational software until such time as the situation was clarified. It was also considered that teletype could not be operational at system commencement because of hardware delays and inability to test. The decision was made to operate with dedicated circuits because they were offered by Bell Canada and this type of arrangement would be superior for the user in Pilot-System operation.

The Handler and the application were progressing favourably until the period of operational testing was entered. A major problem was then encountered with the operating system software, because it was found that the programs as written could not run on the system. Each time they were tried a system halt would be encountered, causing a cessation of operations for ALL users of the system.

At first it was thought that the programs had not been correctly written. The operating system was not suspect, because it had been running normally on all other operations. Considerable loss of time was encountered through the necessity of fault analysis and the applications programs could not be tested with terminals. Special service routines were written to enable some testing of the applications programs.

The problem was finally isolated as an operating system fault. Although the programs were written in accordance with the computer software specifications, the actual system operated in a different manner. The problem was that the software masked an entire word, and the documentation stated half-words.

This resulted in wrong information being stored in a full register which then caused a system halt. Once the problem was isolated, it was corrected in one day. Loss in time to the project was in the order of two man-months.

9. Initial Demonstrations

On July 8, 1971, a demonstration was carried out before a gathering of twenty people from education, industry and government. Each function of the system was explained in detail. Its potential in education was covered, as well as the applicability to other boards of education.

During the summer months it was not possible to put the system to useful purpose and the decision was made to defer operation until the commencement of the next school year. It was acknowledged that the commencement of a school year is a more difficult time to operate pilot-systems, because of the heavy demands on staff.

10. System Constraints

Operation of the system brought out two major constraints that necessitated changes in method:

- *Core Store*: The application programs were written in COBOL, for ease of development and early operations. The resulting system occupied almost 140K bytes of core store and this was more than could be tolerated because of the unfavourable interaction with revenue operations.
- *Teletype*: Dedicated teletype circuits could not operate along with dial up operations. Although no teletype was in the system prior to the educational operation, it was necessary to convert to dial up operations, in order to support other revenue applications.

Both adjustments were accommodated. An overlay system was introduced to reduce core occupancy to one partition for transaction operation. This was completed by September 7. The conversion of teletype was completed by September 15. This programming was not contemplated initially.

11. System Operation

Prior to school opening on September 7, it was recognized that the data base from the previous student information system consisted of obsolete data. The Pilot-System was not initially designed for the creation of large amounts of new data. In order to simplify operations for the school and expedite system operations, the following steps were taken:

- *Student Information Sheets*: These were designed for each student in the school to complete, and were distributed through the home-room teachers. Upon return of the sheets, the data was punched into cards. It required four cards to cover each student. The Student Information Sheet is shown in the Appendix.
- *Load Programs*: These were written to transfer the input data to magnetic tape as the records existed in the previous system. This extra programming was completed in time to use the bulk load data as it was returned from the school.

The Student Information Sheets were not completed by the students in a satisfactory manner and a large number were returned so they could be properly finished. This increased the time required for file creation.

After the second round of information seeking, the files were loaded into disk storage for operation. Listings were made from the data base as follows:

- Student listing — alphabetic
- Student listing — by student number
- Home Class listing
- Staff listing — alphabetic
- Staff listing — by staff number

With the files loaded on the basis of the information that was obtained from the students, many of the details were still outstanding. A new listing program was written for the purpose of producing a one-page report, for each student, of the file content with the stored and the missing information shown. These sheets were produced in duplicate. The school distributed one sheet to each student and retained one for reference.

As has already been mentioned, the operation of the Pilot-System presented additional work for the administrative staff during a busy part of the school year. The office staff encountered difficulty in carrying out their everyday activities while they were also attempting to load the files of the Pilot-System. An additional operator was therefore supplied to assist in file creation and to carry out the many additions and deletions necessary to update the data base. This was accomplished over a two-week period, after which new listings were produced for the convenience of the operating staff. This time-span was also used to give further explanations of operational procedures during periods of system malfunction.

12. Operational Experience

Operation of the system is categorized as follows:

- Technical
- Information
- Usage

Each topic is covered separately, and it should be realized that interaction exists between them. For example, technical or software constraints relate to the operational functions and how they are carried out.

(a) *Technical:* The terminals have been installed since April, 1970 and few service calls have been made. Some of these were for malfunction of the terminal and the others for disconnected cabling.

On one occasion it was found that noise was present in the data circuits. After considerable checking, the problem automatically cleared itself without the necessity of making any readjustments.

The processing centre has been responsible for a number of system outages. These were caused by:

- Changes to system equipment
- Alteration to air conditioning and water systems
- System halts due to hardware breakdown or software problems

The most frequently occurring reason for the interruption of operation is system device failure and software problems. Although the occurrence and distribution of interruption has not been tabulated, it is known that the most frequent interruption is also the shortest, lasting for a few minutes. Each time the system is interrupted, it is automatically re-started by the controllers of the system and the integrity of the stored data is not affected.

(b) *Information*: The information content of the system is in continuous use and constantly updated. The computer operated files are more accessible and up-to-date than the manually maintained records. It will be recognized that the manual recording is continued because of the non-permanent nature of a pilot-system. However, in a production system, the majority of manual files and the operations upon them would be eliminated.

(c) *Staff Records*: The staff file is used for general storage and retrieval purposes. It is also used for the registering of payroll changes. The UPDATE card produces the old and the new salary which becomes the input to the county payroll system. (In a developed system, one file would serve the total purpose.) The method of processing payroll changes represents a considerable saving in clerical work.

The STAFF RETRIEVAL and the UPDATE cards are used mainly in the Board of Education office. The terminal offers a fast and accurate method of operation. The teletype machine is used for entry of major changes to the data base, such as names and addresses.

(d) *Student Records*: These are maintained by one operator. As with staff records, major changes are carried out by teletype and the more frequently occurring items of information are handled by transaction cards. The student listings produced from the data base are in constant use by the administrative and teaching staff as a reference for the mechanized files. Although manual records are maintained, it is accepted that the mechanized file is the most accurate and up-to-date source for information.

(e) *Student Absence Reporting*: This was not begun until early in January. The initial exercise is to input student irregularities. The attendance system is organized in accordance with previous practice and many differing opinions are held regarding the operation. It is possible to record student absence by subject rather than by class period. The amount of teaching and clerical effort that is associated with attendance/absence reporting is large, and it is evident that an instant-access system would have operational benefits.

(f) *Student Testing*: This has been conducted by some teachers and also at another high school. The operational concept is good, the cards contain a sufficiently large number of questions to provide extensive coverage of the subject-matter. This, however, creates some problems with students who have had no previous machine experience. Those students who had some prior knowledge of mark sensing turned in better results. The technique and fast turn-around were completely acceptable. The test card will require more software checking for full operational use. Observations of the test card in use indicate that good potential exists. Some teachers expressed the opinion that the summary of results affords them rapid and timely appraisal of their students' knowledge. It is also felt that there could be a possible convergence between the teaching and testing methods. Because the results are immediate and include the correct answers to the questions, instant reinforcement is provided. Also, the teacher does not have to wait before reviewing those areas, or subject-matter that was not well understood.

(g) *Information-Operation of the System*: This reveals that the storage layout and content (which was taken from a previous system) is inefficient and could be re-organized with considerable saving in space. The information carried is also inefficient and reconsideration could be given to its value and frequency of usage. The introduction of an instant-access system in an environment where there was no previous familiarity tends to considerably affect its environment.

There is also likely to be information that should be included in a new system of which the user may not be presently aware.

(h) *Usage of the System*: This has been both productive and informative. It has shown conclusively that it is easy to use and that it does not require special skills or training. The communications and transaction terminals were arranged to carry out similar operations, wherever possible, in order that a comparative evaluation could be made. The operational observations are both interesting and useful.

The transaction terminal is used by both the office and teaching staff, as well as the teaching staff of another secondary school. Cards are made up as the information arises and input to the system at the staff's discretion. Malfunction of the system has had a minimal effect upon transaction operations, because of the buffering effect of the cards. An operator may be using the system while involved in general office activities.

The teletype terminal is used for name and address changes in the system, or other involved but less frequently occurring data. The teletype machine is a familiar device. Its operation is easily mastered by most people who have any typing experience. Being well within the frame of reference of the user, its acceptance is predictable and it is often used as a reference for comparison rather than for the work to be done. Operation of the system has shown that a person using a teletype machine can readily input data. This could be further improved if the teletype operation was developed strictly for data input rather than for both input and comparison with transactions operations.

The teletype operation is good for the larger inputs, such as student names and addresses. These fields of information change less frequently than smaller ones, such as telephone numbers, attendance, salary levels, etc. In addition to these operations, there is the student testing function. None of these types of operations are cost effective for communications-oriented terminals. Although the CRT display-type terminal was not used, its characteristics are similar to the teleprinter with the exception of its speed and the lack of hard copy output.

The communications-oriented terminal demands the full attention of the operator. This is recognized by the other members of the administrative staff, who will not interrupt her when she is using the teletype machine. As one operator put it, she likes teletype, because when she is using it no one bothers her. It is the only place in the office where she can "hide". However the operators do not have any awareness of the high cost of an exclusive teletype operation.

Since transaction procedures are a new routine, the operator requires a good deal of time before her knowledge of the method is sufficient to enable her to make useful comparisons, using the work to be done as a reference. Nevertheless, it is entirely evident that the operators are comfortable with the routine and readily accept it among the continuous multitude of tasks with which they are confronted. There is never any problem regarding another person using the terminal, because of the short time required to complete a given transaction.

One other advantage of the transaction approach is that data may be accumulated on cards for use in a later operation, which is not possible on the communications-oriented terminal without additional complexity and cost. This feature has proven itself during periods of system malfunction, which may occur more often in a pilot-system than in a completed system.

The administrative activity is continuous throughout the school day, and appears mainly as transactions. It is entirely possible for one transaction terminal to keep up with activity in a school of 1200 or more students.

This could not be achieved with a communications-oriented terminal. Several would be required. For example, attendance reporting and student testing could not be carried out effectively in any other way.

The positioning of the terminal is important, since it rapidly becomes the centre of activity, and this point should be kept in mind when deciding the best place to locate it. For example, it is not practicable to put a terminal at the back of the administrative office, because this tends to decrease its activity and makes it more difficult to establish it as a focal point.

Operation of an administrative office in the transaction mode does have an effect upon personnel. One clerical worker could readily embrace such operations as the updating of attendance records and general office tasks.

There is a need for both transaction and communications-type operations, particularly at student enrolment time. The requirement for full-time use of a communications-oriented terminal is marginal. Communication operations may be treated in another time domain (batch) in a fully developed system without loss of office efficiency. For example, student registration details could be input at the board office or at a few selected locations throughout the county (assuming a system operates throughout the county).

The volume of transactions experienced in the Pilot-System varied considerably. It ranged from as low as ten cards per day to as many as two thousand. Student testing presented a peak in transactions. In one case, one hundred and sixty students were marked by the computer in twelve minutes and fifty-eight seconds, and in another, two hundred and sixty students were marked in twenty-six minutes.

The registration of student absence also presented a continuing transaction volume. The circuit is capable of six to eight hundred typical messages per hour and there were no occasions where the system was unable to accept transactions at the rate they were being produced. Teletype is used as required, on the average of about ten times a day. The operational characteristics of teletype are similar to transactions; therefore, the incidence of use appears higher than it would be if the software was not developed for comparative purposes.

13. Future Possibilities

There are many possibilities for instant-access data systems in education. The two major needs are improvements in administrative systems and a reduction in their costs. It is emphasized that improvements in administrative systems interact with the teaching function and must reduce the administrative distraction.

The areas of application for a developed system in the concept of the Pilot-System are as follows:

(a) *Staff Records*: The staff record file should also be used for payroll and other accounting functions, thereby eliminating the necessity for two separate operations. A general-purpose file scanning program should be written, to allow management to obtain statistical information from the file and to have the processor simulate conditions according to a given set of parameters.

(b) *Student Records*: These should be completely implemented so as to be interactive with students' activities. This means that students' marks, interest profiles and instructors' comments should be mechanized, in addition to the personal and attendance information that is already recorded. The file-scanning program required for the staff file should also be applicable to the student file.

(c) *Attendance Records*: Student attendance records should be completely mechanized and integrated with the remainder of student records. It is practical to have the processor control attendance, once the absence input has been entered. The processor may automatically issue notices to the administrative staff with the necessary supporting information. This greatly reduces administrative activity, while at the same time improving accuracy, because of computer control and simplified operations.

(d) *Student Testing*: This may be developed in a number of different ways. The simple approach and instant processing bring the teaching and testing functions closer together. Arrangements should be made for a teacher to use a terminal within a classroom as required. A more comprehensive analysis of class results should be provided to assist the teacher in correlating results with teaching emphasis.

(e) *Student Reports*: These may be produced automatically by the system. (It is possible to input student marks on all subjects, in a manner similar to attendance reporting.)

(f) *Inventory*: School supplies and equipment may be recorded in the system, so that control over their use is achieved. This also applies to library activities.

(g) *General*: There are a number of activities that are important in operation and cost, that may be mechanized by the system because of the other functions carried. Many of those are not normally associated with computer systems and are handled as an overload by the administrative and teaching staffs:

- Mailing Lists: The system may automatically produce form letters AND addressed envelopes from the student and staff files as required. (Because the files are on-line, there is no question of accuracy.)
- Surveys: These may be implemented as transactions and the results tabulated by the computer. These may cover such items as student preference in subjects, careers, family statistics, summer job details, etc.
- Transfers: This is the automatic production of student/staff information, as people move in and out of the system.

The objective in future applications is to create a merger between activity and events in education and the information that pertains to them. This requires data entry and output devices throughout the educational system. When information processing is integrated in this way, redundant information, pending files and uncertainty disappear. People operating the terminals become less conscious of the presence of the computer and may, in time, consider the system as an operational and economic necessity.

14. Economic Implications

Conventional budgeting methods classify expense in a manner that follows closely along the lines of accounting. Information systems tend to cut across these traditional lines of demarcation, which sometimes make their effectiveness not immediately visible. By way of example, the administrative distraction of the teaching staff would be reduced, but this would not be reflected in the administrative budget.

The administrative system presently in use consists of teachers and administrative staff, manually-operated filing systems and some computer-operated functions, such as payroll. An instant-access system of the type described in this report interacts in these same areas; however, the emphasis changes considerably. Once data is input to the system, it is maintained by the system rather than by operating staff. This releases the support staff from their work load.

(a) *Savings*: The pilot-system shows that the operating administrative staff could be reduced by a minimum of one person in the secondary school and one in the board office. This is based upon the functions presently embraced. In a finished system, which would include the routine functions covered in Section 13, additional savings in operating staff could be achieved, and these people could be assigned to other duties. This would not include any improvements on the teaching side.

In viewing the system from a different perspective, it would appear reasonable, considering the techniques and facilities involved, to assume an all-inclusive cost of one dollar per month per record maintained, using manual methods. (The cost of a separate listing in a telephone book is thirty to sixty cents per month.) This cost covers both personnel and facilities, with personnel as the major portion. Assuming this system would achieve a nominal reduction of half the cost, the saving then becomes five hundred dollars per thousand records.

None of the savings mentioned cover teaching staff, and it is reasonable to assume that benefits would also occur in this area. On the basis of mechanized attendance records, the teacher involvement with administrative duties was reduced by about one hour per teacher, per week, thus increasing the time they could spend on teaching.

The testing function also increases the time available to the teaching staff. With the student testing facilities of the system, a teacher could easily operate one test per class subject each week. The minimum time required to mark a test of this type would be about one minute per student on the average. This would reduce the administrative distraction of each teacher by at least one hour per week.

(b) *Costs*: The cost of systems to mechanize the functions described can vary according to the operating criteria chosen. It should be kept in mind that education systems are highly transaction-oriented, and the type of system required in the administrative application must be in support of this philosophy. Although systems have been attempted in this area previously, they were off-line and no consideration was given to instant-access, its costs and its benefits.

Representative costs for a system of modern technology and software complement are used for the development of a system cost. The central processing complement required to operate the functions described can be handled efficiently on a medium-sized system consisting of the following:

- Processor 16,000 words
- Real-time Clock
- Magnetic Tape (2)
- Disk File — 30 million characters
- Line Printer
- Serial line interface — 8 lines

This complement of system hardware and its maintenance is in the order of six thousand dollars per month. It has the capability of handling as many as forty thousand records of the type described in this report. The software system is also convenient for the type of applications required.

The terminal equipment requirement may be established conservatively at one terminal per thousand students, on the average. Communication costs are difficult to assess without a system configuration. The cost of circuits of the type required is approximately four dollars per mile per month.

A system to cover the function described and to operate in a complex of about twenty secondary schools would cost in the range of fifteen to twenty thousand dollars per month. These estimates are based on a variety of likely approaches in system operation and equipment. As operating experience is accumulated and refinements implemented, the ratio of costs to savings would improve beyond the initial advantages.

15. Conclusions

(a) Dealing with administrative information is a major involvement in primary and secondary school education. The cost of administration is classified for budgetary purposes, as is the cost of computer service and instruction. These formal boundaries make it difficult to assess the cost of information as a commodity; therefore, the true cost of dealing with administrative information is relatively unknown.

(b) The major source of information for the proposed transaction-oriented system occurs within the area of instruction and therefore cannot appear as a clearly defined cost item. The involvement of the instruction staff as well as the administrative staff in dealing with this type of information should be dealt with as a cost item entitled "administrative distraction".

(c) The development and operation of the Pilot-System involved much collaboration and observation of events within the instruction area. The instruction staff is burdened with the preparation, recording and operational use of data. This embraces student records, attendance reports, test marking and recording of results, monitoring of previously recorded data for possible action, personal interviews regarding previously recorded data, etc. It is conservatively estimated that 4 percent of instruction cost is associated with administrative distraction.

(d) The major cost of information services is contained within the cost of instruction. Computer operations are not the major cost. The appearance of computer controlled information processing systems will not eliminate administrative distraction but they will reduce it to an acceptable level. The following table is an example of cost distribution for an assumed medium-size school-board. It will be noted that a 50-percent saving (of at least $800,000) should be realized through the improved response and operational disciplines of the computer operated information system. (See Table 1).

(e) Savings in the instruction area may be translated into teachers' salaries at the secondary school level (which average in the area of $11,000); therefore, the presence of the system is equivalent in teaching power to:

$800,000 / $11,000 = 73 teachers (approximately)

(f) Discussions of system possibilities with staff members reveals dissatisfaction with existing methods. This is focused mainly on the increasing administrative burden and the failure of batch-processing methods to provide the service expected. The simplicity, response and the accuracy of instant-access systems, on the other hand, eliminate the intermediate procedures, delays and ambiguities that must be tolerated with the conventional approach. The opinion of staff members, in both administration and instruction, is that systems providing a similar response and operational coverage will be required in the near future to satisfy the growing needs of education.

(g) A number of students have also been exposed to the system through the facility of on-line testing, demonstration and explanation of system operation. Enthusiastic acceptance by the students was expressed, particularly with the immediate results of their tests, the system accuracy and the operational coverage. The presence of the system also does much to make students more aware of the power and necessity for modern information technology in today's society. Although university students of a few years ago were rebellious regarding the presence of computer systems, it is becoming increasingly likely that, over the next few years, the secondary school students may become rebellious because of the absence of responsive systems. The basic complaint will be that information is not brought into better alignment with activities as they occur.

(h) The province is ultimately destined to operate with a number of multiple-access, multi-processor networks for education. This will afford the

Table 1
Annual Cost — Medium-Size School-Board

Total Budget	$61,500,000
Instruction	40,000,000
Computer Services & Terminals (as proposed)	250,000
All Other Costs	21,250,000
Cost of Administrative Distraction in Instruction Only @ 4% and Without Proposed Responsive System	1,600,000
Cost of Administrative Distraction with 50% Reduction in Instruction Only and with Proposed System	800,000
Saving (instruction only)	800,000
Total Information-Handling Costs	1,050,000

Department of Education more timely and accurate information for the evaluation of the financial requirements of education.

(i) The Department of Education establishes the basic requirements of information and its use. This, in turn, reflects upon the software architecture of the networks and their fundamental operations.

Appendix

Description of System Operations

Introduction

Producing a system which would satisfy all the needs of education is obviously beyond the capacity of any single project. However, a pilot-system, such as the one we have been describing, is of considerable value. It is obviously worthwhile to develop operational systems which, even though incomplete, are structured in such a way that they provide realistic experience in further system development, and which also aid users in conceptualizing the final goals they hope to achieve.

In order to present a more concise picture of the actual technical problems involved, the following pages include various practical examples of the methods used in the Peel County Pilot-System.

Figure 1 *Student Information Sheet*

This sheet was completed by each student at the commencement of the school year. The information was keypunched and loaded into the computer off-line. In the majority of cases the form was not fully completed in the first instance and additions were made on-the-fly, as operational transactions, after system operation had commenced.

Figures 2 and 3 *Storage Layout*

The storage layout of the system is shown for both student and staff records. The layout is an aggregate of individually numbered information fields, each of which may be accessed as an operational transaction.

Each field is labeled in COBOL-like nomenclature for use with communications terminals (teletype) and also in a simple mnemonic manner for use in the transaction method of operation (Transaction Cards). The storage efficiency would be increased considerably for a fully implemented system. Not all of the fields were implemented for transaction mode of operations.

Figures 4 and 5 *Transaction Terminals*

The transaction terminal is a device that accepts input messages that are prepared by an operator external to the system. The card is dropped into the terminal by the operator and the message is automatically sent to the computer. The reply from the computer is printed directly on the input card which is then returned to the operator. The entire process is completed in four to six seconds.

The terminal is illustrated in the following photographs. It may be mounted within a desk surface which facilitates card marking by the operators. Operational cards are marked by the staff. The students also mark their own cards when involved with student testing.

Transaction Card Examples Figures 6 to 10

The following transaction cards were implemented for use in the Pilot-System with a brief description of their function. Information input is scored by means of horizontal pencil marks within the appropriate information fields. Erasures may be made and the cards re-marked whenever necessary.

The printer operates automatically and in accordance with the applications program used. The last print line scanned may be used to control operations. Marks in this area may be pre-printed on the card and also printed by the applications programs. In the Pilot-System the pre-printed (binary) marks are used to define the input matrix format and hence the applications programs to be used. In some cases the program adds binary marks to indicate that if the card is used for an additional operation, the appropriate action may be taken.

Figure 6 *Student Test Card*

This card is used by the students to answer multiple-choice questions. The questions are marked in accordance with a question sheet prepared by the teacher. The same card is used by the teacher for entering a reference matrix to the computer for marking the students' cards. Similarly the same card format is used by the teacher to produce a summary of results.

For student reinforcement, the correct answers to questions marked wrong are printed by the computer in the vertical result area which is three characters wide. The additional marks printed in the last print line are to prevent the card from being processed, and re-entered.

Figure 7 *Staff Retrieval Card*

This card enables information to be withdrawn from the system according to the information fields marked. Only the information requested will be printed. If the information requested exceeds the print area, a light flashes on the terminal to indicate that the card should be re-entered on its reverse side, so that printing may continue on the back of the card. The numbered fields printed on the card were not implemented for the Pilot-System.

Figure 8 *Student Retrieval Card*

Similar in operation and format to the staff card but operates on the student file.

Figure 9 *Attendance Card*

Used by the teacher to report absence of up to five students at a time. The absence is automatically recorded in the students' record.

Figure 10 *Update Card*

This card is used by the staff to update any field within a record. Either the staff or student file may be entered. Alpha or numeric information may be marked within the central part of the mark area. To provide maximum integrity the card is used twice with the existing as well as the new field contents being printed on the first insertion of the card. After verification by the operator, the instruction ENTER may be marked, which will complete the update process and cause the word "updated" to be reprinted at the bottom of the card. This card covered the majority of operations of the system where changes to records were required.

Figure 1

Student Information Sheet

Figure 1

T. L. KENNEDY - STUDENT INFORMATION SHEET.

- INSTRUCTIONS -
BLOCK PRINT YOUR ANSWERS
MARK 'X' IN THE APPROPRIATE BOX

1

2 TIME TABLE NUMBER: 231 0456

9 STUDENT - SURNAME AND GIVEN NAMES: FLANAGAN MICHAEL

39 GIVEN NAME USED: 1 [X] 2 [ ] 3 [ ]

40 MALE 1 [X] FEMALE 2 [ ]

41 PROTESTANT 1 [X] R. CATHOLIC 2 [ ] JEWISH 3 [ ] OTHER 4 [ ]

42 DATE OF BIRTH (d m y): 28 11 53

48 SOCIAL INSURANCE NUMBER: 447036234

57 REGISTRATION (d m y): 07 09 71

63 TOTAL YEARS IN SECONDARY SCHOOL INCLUDING THIS YEAR: 4

(MILES TO SCHOOL (decimal)): 4.5

68 STUDENT PHONE NO.: 2924260

2

9 LAST BOARD NO.: 16

11 LAST SCHOOL NO.: 112

14 HOME CLASS NO.: 401

17 TRANSPORTATION: 1 [ ] 2 [ ] 3 [ ] SCH. BUS 4 [X] PUB. TRANS. 5 [ ] OTHER 6 [ ]

18 STREET ADDRESS, RURAL ROUTE OR P.O. BOX NO.: 2540 HURONTARIO STREET

NAME & ADDRESS OF LAST SCHOOL ATTENDED: THORNLEA SECONDARY THORNHILL ONT.

46 APT. NO.

POST OFFICE & PROVINCE: MISSISSAUGA

75 PROTESTANT 1 [X] R. CATHOLIC 2 [ ] JEWISH 3 [ ] OTHER 4 [ ]

3

9 MALE GUARDIAN SURNAME: FLANAGAN

24 INITIALS

MR. 1 [X] DR. 2 [ ] REV. 3 [ ] OTHER 4 [ ]

27 RELATIONSHIP: FATHER 1 [X] STEP-FATHER 2 [ ] FOSTER PARENT 3 [ ] LEGAL GUARDIAN 4 [ ] OTHER RELATIVE 5 [ ] HUSBAND 6 [ ] OTHER 7 [ ]

28 BUSINESS PHONE NO.: 2781212

35 FEMALE GUARDIAN SURNAME: FLANAGAN

50 INITIALS: HJ

52 MRS. 1 [X] DR. 2 [ ] MISS 3 [ ] OTHER 4 [ ]

RELATIONSHIP: MOTHER 1 [X] STEP-MOTHER 2 [ ] FOSTER PARENT 3 [ ] LEGAL GUARDIAN 4 [ ] OTHER RELATIVE 5 [ ] OTHER 6 [ ]

54 BUSINESS PHONE NO.

4

9 FATHER ALIVE: YES 1 [X] NO 2 [ ]

10 MOTHER ALIVE: YES 1 [X] NO 2 [ ]

11 DOCTOR SURNAME: KILDA...

26 INITIALS: JB

28 DOCTOR'S PHONE NO.

35 PHYSICAL DISABILITY: YES 1 [ ] NO 2 [X]

36 HEALTH PROBLEM: YES 1 [ ] NO 2 [X]

37 CONTINUING MEDICATION: YES 1 [ ] NO 2 [X]

1. IS STUDENT SELF SUPPORTING? YES [ ] NO [X]
2. NUMBER OF CREDITS COMPLETED AS OF SEPT. 1st: 1
3. LOCKER NUMBER: 1282

ARE YOU ENTITLED TO A YOUTH ALLOWANCE? YES [ ] NO [X]

ARE YOU A RESIDENT OF PEEL COUNTY? YES [X] NO [ ]

ARE YOU A RESIDENT OF THIS SCHOOL AREA? YES [X] NO [ ]

(SIGNATURE)

T-SCAN LIMITED, Toronto, Canada

Figure 2
Peel County
Student Record
(452 CHARACTERS — TOTAL)

FIELD	*TELETYPE LABEL*	*TRANSACTION CARD LABEL*
1	X08STDNT-NMBR	STUNO
2	X30STDNT-NM	STUNAME
3	X01GVN-NM-USD	GIVNAME
4	X01SX	SEX
5	X01RLGN	RELIG
6	N60BRTH-DT	BIRTHDA
7	N90SCL-INSRNC-NMBR	SIN NO
8	X01ACTVTY-INDCTR	ACTIVITY
9	X06RGSTRTN-DT	REGDATE
10	N50RTRMNT-RSN/CRTFCTCD	RET & CER
11	N60RTRMNT-DT	RETDATE
12	N30F-PD-CD	FEE-PAY
13	X01GRDNS-RLGN	GURELIG
14	X01GRDNS-TX-SPPRT	GU TAX
15	X02YR	YEAR
16	X20LST-BRD-NM	LBNAME
17	X20LST-SCHL-NM	LSNAME
18	X05HM-CLSS	HOME CL
19	X20TRNSFR-SCHL-NM	TRANSCH
20	N60TRNSFR-DT	TRANDAT
21	X05TRNSFR-HM-CLSS	TRANCLA
22	X01MTHD-OF-TRNSPRTTN	TRANSPO
23	X04DSTNC-FRM-SCHL	DIST
24	X08BS-NMBR	BUS NO
25	X28STDNT-ADDRSS	
26	X05APRTMNT-NMBR	
27	X25PST-OFFC-AND-PRVNC	
28	N70HM-PHN	HOMEPHO

29 X15ML-GRDN-SRNM
30 X02ML-GRDN-INTLS
31 X03ML-GRDN-TTL
32 X02ML-GRDN-RLTNSHP
33 N70ML-GRDN-BSNSS-PHN
34 X15FML-GRDN-SRNM
35 X02FML-GRDN-INTLS
36 X03FML-GRDN-TTL
37 X02FML-GRDN-RLTNSHP
38 N70FML-GRDN-BSNSS-PHN
39 X01FTHR-ALV
40 X01MTHR-ALV
41 X15DCTRS-NM
42 X02DCTRS-INTLS
43 N70DCTRS-BSNSS-PHN
44 X01PHYSCL-DSBLTY
45 X01HLTH-PRBLM
46 X01CNTNNG-MDCTN
47 N30TRM-LTS (1)
48 N30TRM-LTS (2)
49 N30TRM-LTS (3)
50 N30TRM-LTS (4)
51 N30TRM-ABS-HLFDYS (1)
52 N30TRM-ABS-HLFDYS (2)
53 N30TRM-ABS-HLFDYS (3)
54 N30TRM-ABS-HLFDYS (4)
55 N30TRM-ABS-FLLDYS (1)
56 N30TRM-ABS-FLLDYS (2)
57 N30TRM-ABS-FLLDYS (3)
58 N30TRM-ABS-FLLDYS (4)
59 X20DSTNTN-SCHL-NM
60 X05DSTNTN-HM-CLSS
61 X01RTRMNT-INDCTR
62 N50DT-ABSNT-YMMDD TDY
63 N10PRD-ABSNT (1) TDY
64 N10PRD-ABSNT (2) TDY

65	N1OPRD-ABSNT (3) TDY
66	N1OPRD-ABSNT (4) TDY
67	N1OPRD-ABSNT (5) TDY
68	N1OPRD-ABSNT (6) TDY
69	N1OPRD-ABSNT (7) TDY
70	N1OPRD-ABSNT (8) TDY
71	N1OPRD-ABSNT (9) TDY
72	N3OPRD-ABS (1) TRM 1
73	N3OPRD-ABS (2) TRM 1
74	N3OPRD-ABS (3) TRM 1
75	N3OPRD-ABS (4) TRM 1
76	N3OPRD-ABS (5) TRM 1
77	N3OPRD-ABS (6) TRM 1
78	N3OPRD-ABS (7) TRM 1
79	N3OPRD-ABS (8) TRM 1
80	N3OPRD-ABS (9) TRM 1
81	N3OPRD-ABS (1) TRM 2
82	N3OPRD-ABS (2) TRM 2
83	N3OPRD-ABS (3) TRM 2
84	N3OPRD-ABS (4) TRM 2
85	N3OPRD-ABS (5) TRM 2
86	N3OPRD-ABS (6) TRM 2
87	N3OPRD-ABS (7) TRM 2
88	N3OPRD-ABS (8) TRM 2
89	N3OPRD-ABS (9) TRM 2
90	N3OPRD-ABS (1) TRM 3
91	N3OPRD-ABS (2) TRM 3
92	N3OPRD-ABS (3) TRM 3
93	N3OPRD-ABS (4) TRM 3
94	N3OPRD-ABS (5) TRM 3
95	N3OPRD-ABS (6) TRM 3
96	N3OPRD-ABS (7) TRM 3
97	N3OPRD-ABS (8) TRM 3
98	N3OPRD-ABS (9) TRM 3
99	N3OPRD-ABS (1) TRM 4
100	N3OPRD-ABS (2) TRM 4

101	N30PRD-ABS (3) TRM 4
102	N30PRD-ABS (4) TRM 4
103	N30PRD-ABS (5) TRM 4
104	N30PRD-ABS (6) TRM 4
105	N30PRD-ABS (7) TRM 4
106	N30PRD-ABS (8) TRM 4
107	N30PRD-ABS (9) TRM 4
108	N50LT-OR-ABSNT-YMMDD
109	X06ABSENT-OR-LATE-ID

Figure 3
Peel County
Staff Records
(650 CHARACTERS —TOTAL)

FIELD	*TELETYPE LABEL*	*TRANSACTION CARD LABEL*
1	XO3SCHL-OR-LCTN-NMBR	LOCAT
2	XO9SCL-INSRNC-NMBR	SIN
3	XO3EMPLY-TTL	TITLE
4	XO2EMPLY-INTLS	INITIAL
5	X16EMPLY-SRNM	SURNAME
6	XO1SLRY-TYP-CD	
7	N52ANNL-SLRY	SALARY
8	N3OYTD-NMBR-PY-PRDS	
9	N32TX-EXMPTN-AMNT	
10	N52YTD-INCM-TX-DDCTN	
11	N32CRRNT-INCM-TX-DDCTN	
12	N3ODYSWRKD-PYPRD-CRRNT	
13	N52ADJSTD-CNTRCT-AMNT	
14	N52YTD-CNTRCT-ERNNGS	
15	N52CRRNT-CNTRCT-ERNNGS	
16	XO6DSTRBTN-CD (1)	
17	XO6DSTRBTN-CD (2)	
18	XO6DSTRBTN-CD (3)	
19	N3ODSTRBTN-PRCNT (1)	
20	N3ODSTRBTN-PRCNT (2)	
21	N3ODSTRBTN-PRCNT (3)	
22	N6OEFCTV-CMNCMT-DDMMYY	START DT
23	XO1PNSN-CD	
24	N52YTD-PNSN-DDCTN	
25	XO1UIC-CD	
26	XO1GRP-INSRNC-CD	
27	N32UNTDAPPL-DDCTN-RGLR	
28	N32RGLR-OHSC-DDCTN	OHSCDED

29	N32RGLR-OHSIP-DDCTN	OHSIPDE
30	N32RGLR-CRDT-UNN-DDCTN	
31	N32MISC-DDCTN-AMNT (1)	
32	N32MISC-DDCTN-AMNT (2)	
33	N32MISC-DDCTN-AMNT (3)	
34	X02MISC-DDCTN-CD (1)	
35	X02MISC-DDCTN-CD (2)	
36	X02MISC-DDCTN-CD (3)	
37	N52YTD-GRSS-ERNNGS	
38	N52YTD-SPRAN-ERNNGS	
39	N52YTD-NN-SPRAN-ERNNGS	
40	N32YTD-UIC-DDCTN	
41	N32YTD-CPP-DDCTN	
42	X01SPRNNTN-CD	SUPER
43	N52YTD-SUP-ERNNGS	
44	N32TXBL-GRP-INS-BNFT	
45	X01FS-DS-DDCTN-CD	
46	N32FS-DS-DDCTN-CURINST	
47	N52YTD-FS-DS-AMNT	
48	X06PSTN-TTL-CD	POSN
49	N60EMPLY-BRTH-DDMMYY	BIRTH
50	N32CRRNT-OHSC-DDCTN	
51	N32CRRNT-OHSIP-DDCTN	
52	X01MDCL-CD-OHSIP	
53	N32BRD-MDCLSBSDY-OHSIP	
54	X01CPP-CD	
55	N90OHSIP-CNTRCT-NMBR	OHSIPNO
56	N90OHSC-CNTRCT-NMBR	OHSC NO
57	N30NMBR-MNTHS-EMPLYD	
58	N52RGLR-ERNNGS	
59	X04SUP-ERN-CD (1)	
60	X04SUP-ERN-CD (2)	
61	X04SUP-ERN-CD (3)	
62	X04SUP-ERN-CD (4)	
63	N32SUP-ERN-HRS/DYS (1)	
64	N32SUP-ERN-HRS/DYS (2)	

65	N32SUP-ERN-HRS/DYS (3)	
66	N32SUP-ERN-HRS/DYS (4)	
67	N32SUP-ERN-RT (1)	
68	N32SUP-ERN-RT (2)	
69	N32SUP-ERN-RT (3)	
70	N32SUP-ERN-RT (4)	
71	N52SUP-ERN-AMNT (1)	
72	N52SUP-ERN-AMNT (2)	
73	N52SUP-ERN-AMNT (3)	
74	N52SUP-ERN-AMNT (4)	
75	N52EMPLY-GRSS-ERNNGS	
76	N12UIC-DDCTN	
77	N32CPP-DDCTN	
78	N32PNSN-DDCTN	
79	N32GRP-INSRNC-DDCTN	GLDED
80	N52TTL-DDCTNS	
81	N52NT-PY	
82	N52SPRNNTNBL-ERNNGS	
83	X01PY-CD	
84	N52SPLMNTRY-ERNNGS	
85	N60CRRNT-PYRLL-DDMMYY	
86	N52NN-SPRNNTNBL-ERNNGS	
87	N32CRDT-UNN-DDCTN	
88	X01FRZN-RCRD-INDCTR	
89	N32ACCMLTD-SCK-LV-DYS	SICK LV
90	X01SCK-LV-PLN-CD	
91	N32MSCLLNS-DDCTN (1)	
92	N32MSCLLNS-DDCTN (2)	
93	N32MSCLLNS-DDCTN (3)	
94	N32MSCLLNS-DDCTN (4)	
95	N32 CRRNT-UNTD-APPL	
96	X01VCTN-ERRR-CD	
97	X01EHB-INDCTR	
98	X01OHSC-CD	
99	X02BRD-NMBR	
100	X30APRTMNTNO-ADDRSS	ADDRESS

101	X25PST-OFFC-AND-PRVNC	P.O.
102	X20GVN-NMS	GIVNAM
103	X16MDN-OR-SCLR-NM	MAIDEN
104	X02MRTL-STTS	MARITAL
105	X02NMBR-OF-CHLDRN	DEPS
106	NAOHM-PHN-INCL-AR-CD	PHONE
107	X29NM-OF-NXT-OF-KN	KIN
108	NAOPHN-NXTOFKN-W-AR-CD	KINPHON
109	X01MLD-CHQ-INDCTR	MAILOC
110	N32SPTMBR-SLRY	
111	N52YTD-PRVS-BD-ERNNGS	
112	N32OHSC-BRD-PRTN-ADJ	
113	N32YTD-OHSC-TXBL-BNFT	
114	N32CRRNT-EHB	EHBDED
115	N32CRRNT-SVNGS-BNDS	
116	N32YTD-SVNGS-BNDS	
117	N52YTD-TSC-CRDTS	
118	N32YTD-NMBR-DYS-LST-PY	
119	X01TSC-CHNG-INDCTR	
120	X01PRSNNL-DT-CHNG-IND	
121	X01ANNL-SLRY-CHNG-IND	
122	N52YTD-NN-TXBL-PY-ADJ	
123	X02AR-CD	AREA
124	N60EFFCTV-DPRTR-DDMMYY	
125	N50DPRTR-RSN	
126	X19DSTNTN	
127	X02FLR-BNS-NO-CLSSRMS	
128	X01BLR-CD	
129	N60ASSGNMNT-DDMMYY	
130	N60PGGD-SLRL-DDMMYY	
131	N60MXM-RCHD-DDMMYY	
132	N32YTD-MDCL-BNFT-OHSIP	
133	N32RGLR-FS-DS-DDCTN	
134	N32RGLR-EHB-DDCTN	
135	X01SCK-LV-CD	
136	N30RGLR-DYS-WRKD	

Peel County Pilot Education System

137	N32YTD-UNTD-APPL	
138	X01VCTN-PLN-CD	
139	N32CMLTV-DYS-VCTN	VACATN
140	N32CRRNT-DYS-VCTN-TKN	
141	N32CRRNT-DYS-VCTN-ADJ	
142	X02LVL	LEVEL
143	N32EXPRNC-TCHNG	EXP.TCH
144	N32EXPRNC-RLTD	EXP.REL
145	N60CNTRCT-DDMMYY	CONTRACT
146	N50BSC-TX-EXMPTN	TAX
147	N70GRP-LF-CVRG-AMNT	GLCOV
148	X01AR	
149	N60X-RY-DDMMYY	X-RAY
150	N60TRMMTN-DDMMYY	TERM DT
151	X25OLFCTNS	QUAL

Figure 4
Transaction Terminal

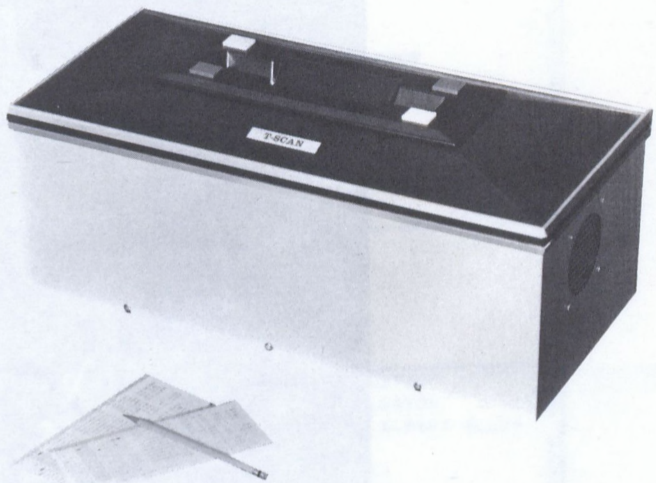


Figure 5
Transaction Terminal Operator

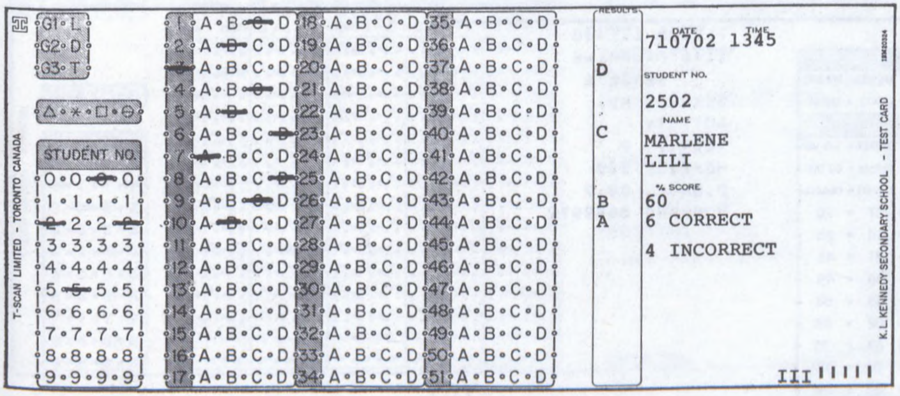


Figure 6
Student Test Card

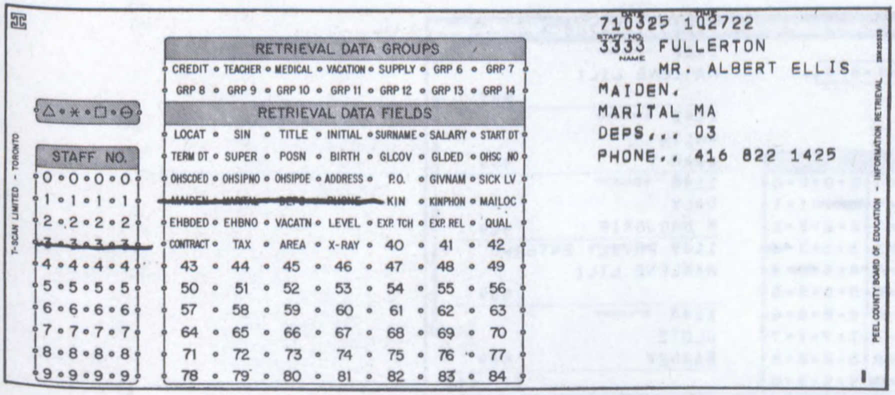


Figure 7
Staff Retrieval Card

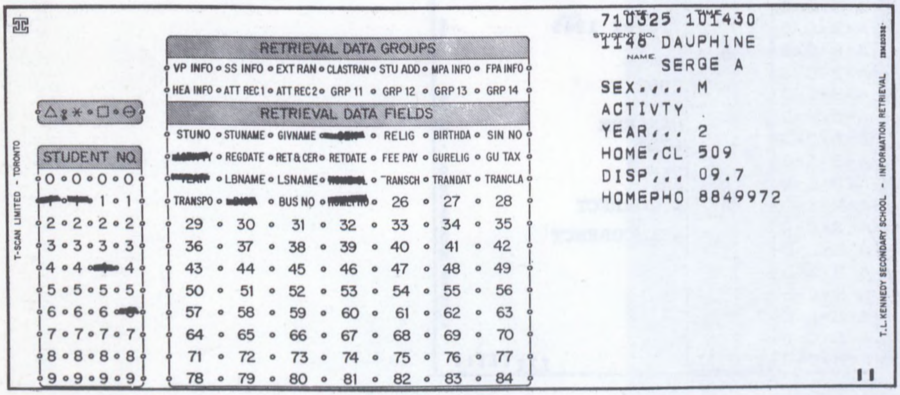


Figure 8
Student Retrieval Card

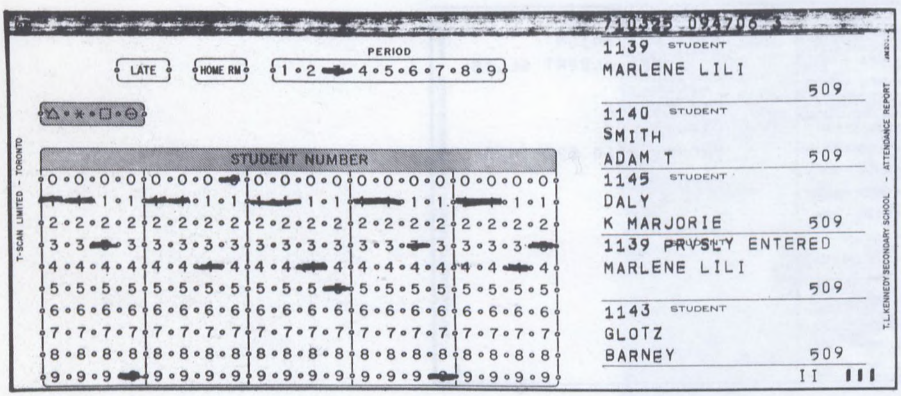


Figure 9
Attendance Card

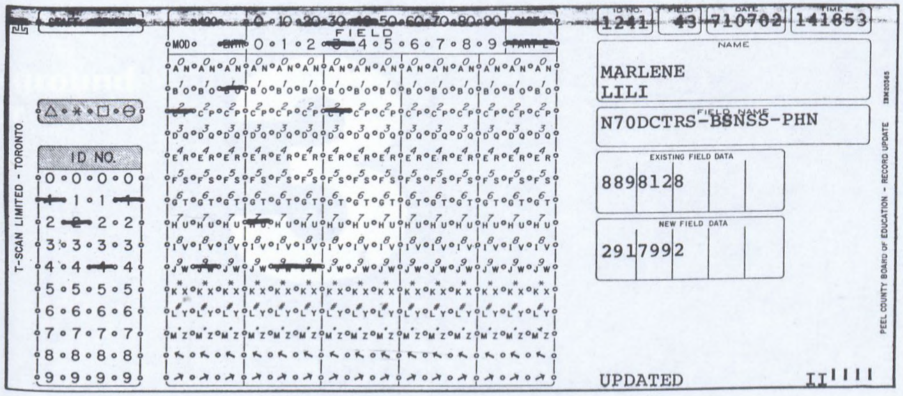


Figure 10
Record Update Card

Background Paper

3

The Canadian Computer/Communications Task Force

Background Papers

3 Computer/Communications Activities at Canadian Universities

(A Survey)

Prepared by:

CCC/TF Ottawa

August, 1972

Table of Contents

Introduction

The Association of Universities and Colleges of Canada lists sixty-three post-secondary institutions in its 1971 handbook with a total full-time student enrollment of about 290,000. According to the Secretary of State's office, total operating expenditure at post-secondary institutions in 1971 was approximately $1.5 billion. The federal government effectively contributes about 50 percent of these operating expenditures, or $750 million. Of this total, computer staff and equipment in Canadian universities in 1971 accounted for about $55 million.

Twenty-eight universities were included in this survey (Appendix A) representing about 85 percent of the total Canadian post-secondary enrollment and $35-40 million of the computer expenditure. Visits or contacts were made with at least one university in each province. The findings in this report are based on over 100 personal interviews conducted during April and May, 1971, with computer centre staff and faculty members involved in developing specialized systems.

The survey attempts to highlight some of the developments taking place in Canadian universities in computer/communications, and some of the needs, problems and issues which have arisen in the pursuit of these developments. Attention is focussed on the significant trends which are emerging, including activities directed towards the sharing of resources, and on special systems, particularly those considered to be socially significant. In addition, supplementary reports are appended in order to discuss in greater depth two areas of importance. Appendix C is concerned with computing services offered by some universities on a commercial basis, while Appendix D covers the proposals for a Canadian University Computer Network (CANUNET).

This report is being published almost eighteen months after the basic information was collected. During that time there have been changes in computer installations at some universities, progress has been made in applications discussed in the report, and there have been new developments in a number of areas. However, many of the basic problems remain. The report therefore, while not now completely up-to-date in its description of on-going activities, does represent a summary of the problems facing universities, their requirements, and approaches that have been taken.

Part A

Computer Centre Systems

For the purposes of this report, computer centre systems are defined as those providing general computing facilities for students, graduate researchers and academic/administrative staff at universities. This section outlines significant trends in the development of computer centre systems; those university needs which are not being met by existing systems; and the role a computer/communications network might play in satisfying such needs.

1. Significant Trends

(a) Continuing Growth in Usage, Especially in Non-Scientific Areas

It appears to be very difficult to provide enough computing time to satisfy all users. Unless the universities start to restrict usage, it seems evident that they will continue to need larger computer facilities.

Physics and chemistry have traditionally been the biggest users of computers. They still occupy the lead positions, but their percentage usage has declined quite markedly at some universities, in favour of the social sciences. Appendix B illustrates the changing pattern of usage at one university. As social scientists are more likely to produce data banks, their increased interest in computers may portend substantially increased usage of computer/communications technology.

(b) Separation of Administrative and Academic Computing

There are currently several methods employed to satisfy these combined needs. Some universities have the two functions amalgamated both organizationally and on the computer; others have them completely separate; and still others have them organizationally separate while using the same facility. There appears to be a trend to complete separation, as the operational requirements for the two user groups are quite different in terms of both computer hardware and service. Larger universities tend to have separate facilities. This trend toward treating university administrative systems as specialized systems may create an environment for co-operation in the development of generalized university administrative computer facilities. The SIGU project in Quebec, a joint program of the Department of Education and all Quebec universities to produce a generalized Management Information System (MIS), is a good example, although the tangible results have not yet emerged. The continued separation of administrative systems from academic systems may also allow academic users increasing flexibility in experimenting with networks. However, at least one university vice-principal feels strongly that this trend will not materialize. Instead he believes that the tight budget squeeze, plus the general trend toward on-line computing, will tend to force a consolidation of administrative and academic computing centres.

(c) Cost Stabilization

University computer centre budgets appear to be levelling off. Some 1975 budgets are estimated to be substantially the same as present ones. Other 1975 budgets are estimated as being double the current levels. However, the overall impression is that the rate of expansion will be slower over the next few years. There are a number of reasons for this: the budget squeeze on universities has been passed on to the computer centres; the trend to a charge-out policy for computer usage is encouraging users to be more efficient in their employment of computer time; the new NRC grant policy is curtailing certain researchers from experimental usage of this facility. The stabilization of computer expenditures may, in the short run, mean that the development of computer/communications facilities for universities will be delayed unless they are funded by a joint university co-operative effort or by an outside agency.

(d) Expansion of Terminal Facilities

The major area of growth at university computing centres is in terminal services. Nearly every university has plans to add new terminals in the next year. These are of both the Remote Job Entry (RJE), and conversational type. In addition, there is growing use of "universal" type terminals which allow the user to access a range of remote off-campus computers using the existing voice-grade circuits. This may well be the forerunner of computer network services. The high cost of communications, however, remains an obstacle. In addition, of course, there will be reluctance on the part of universities to permit individual users to decide between using off-campus services, and the on-campus centre.

(e) Increasing Off-Campus Communications

Voice-grade circuits are being used for a variety of computer applications being processed off-campus for a remote user.

Some examples are:

- University of Alberta to TRIUMF project at U.B.C.
- Saskatoon campus computer to Regina Campus computer at University of Saskatchewan.
- University of Western Ontario CAL experiments in Inuvik, N.W.T., Sarnia, Owen Sound.
- Winnipeg General Hospital to University of Manitoba.
- Simon Fraser University to Kelowna.
- University of Western Ontario to SDL, Computel, IBM, and Multiple Access.
- Loyola College to McGill.

There appears to be no reluctance to use off-campus facilities if the local computer cannot meet user requirements. Most users are reasonably happy with communications services but find the costs excessive.

(f) Development and Marketing of Computer System Application Packages and Services

The slowly-developing trend among users toward "buy" not "make" has created opportunities for universities to develop and market their own packages. Here are a few examples:

- SAFFRASS: Geological Storage and Retrieval System is installed at several universities. The University of Western Ontario is developing a licensing agreement for this system and plans to market it actively.
- University of Western Ontario Administrative System is being considered by a number of other universities.
- University of Guelph Government Documents System is installed and operational at several universities.
- University of Waterloo has sold the WATFOR and WATFIV compilers widely.
- McGill has licensed the use of their McGill RAX System in seven installations in the U.S. and one in Sweden.

- Some universities have also been active in the sale of computer time (with or without services) on a commercial basis.

These commercial activities, while sometimes lucrative, are causing the universities some concern. In addition to being criticized by the commercial service bureaux for competing from a favoured position, they are concerned about moving into an area which is not in keeping with the concept of a university and is in conflict with their traditional means of funding. Appendix A comments on the factors associated with this activity.

(g) Growth in Regional Co-operative Groups to Reduce the Amount of Duplicated Effort

Each university effectively develops its own systems. This means that at most Canadian universities there are different administrative systems, library systems, accounting systems for computer usage, etc., which, with few exceptions, have been conceived, designed, programmed, tested, and made operational without co-operation and at considerable expense. There are signs that universities in some provinces are beginning to realize that some form of rationalization is warranted. For example, organizations have been formed in Ontario and Quebec to co-ordinate joint purchases of software packages, develop information exchanges, share operating experiences and design computer networks. The basic principles of these regional organizations could be applied on a national basis, the only major disadvantage being the problem of handling communications between widely separated universities. The significance of this move to rationalization is that it may create an environment where a computer/communications network can be more readily justified and more easily implemented.

2. Satisfying Outstanding Needs with a Computer/Communications Network

Recently, a great deal of interest has been aroused in university circles regarding the potential for greater flexibility in computing which is being brought about by the advances in computer/communications networks. Perhaps the prime source of this interest stems from the ARPA network in the United States. In Canada, with far fewer resources at our disposal, such a network is seen as a way of overcoming some of the problems associated with university computing. This is not to suggest that other methods do not exist, or are less important, but rather that networks have become the focus of attention in this regard.

The university environment tends to create new computing needs on a continuing basis. Most of these are handled in a capable way by the computer centres, but there are some requirements which they have difficulty meeting.

Key problems in this area are listed below with suggestions as to how a computer/communications network might assist in their solution.

- *The general growth patterns of computer usage are forcing nearly all universities to upgrade their facilities.* Because of budget constraints, this is posing a problem, particularly since universities acquire new facilities with a view to meeting their general needs for about five years. Unless some formula can be worked out with the supplier, the university tends, in the early years, to pay for more computing power than is necessary.
- A computer/communications network could provide universities access to a computer used on a shared basis. Rather than acquire a larger computer when the existing one is operating at full capacity, a university could use the shared computer for a period of time until its usage had built up to a point where a new acquisition was appropriate. The net effect of this approach could decrease the rate of investment in university computers.
- *Most computer centres are unable to meet the demand for adequate on-line or real-time services.* The causes of this problem are varied. Some universities ascribe it to the difficulties encountered when trying to serve both batch and on-line users. Others see it arising from inadequate operating systems. In a few instances, it may be due to the down-time experienced with non-duplexed time-sharing systems.
- A computer/communications network could alleviate this situation by providing facilities for batch-processing off-campus and

allow the university to acquire more specialized systems for time-sharing and real-time processing. However, some universities are very happy with their combined batch and time-sharing systems, and at least one university feels that any separation would result in an overall degradation of service.

- *Most universities are not well equipped to handle large "number-crunching" jobs.* These jobs are usually required by only a small number of users but may utilize about 30 percent of the available computer time.
- A computer/communications network could provide access to a large "number-crunching" facility to handle this segment of computing for a group of universities, thus extending, by a substantial margin, the useful life of existing facilities for other work.
- *Service during peak-load can decline to an unacceptable level.* A computer/communications network of commercial as well as university centres could provide access to spare capacity for peak-loads, and take advantage of different time-zones, thus reducing the need for internal facilities to cope with greater-than-average loads.
- *The computer centre is often unable to get access to specialized hardware, programs or data required by a researcher.* As a result, there can be excessive cost and delay in converting a system to the university computer.
- A computer/communications network could allow a user anywhere on the network to access hardware, programs, or data at any other location on the network. In addition to eliminating conversion costs, there is the added advantage that the system could be used where it was developed and maintained, and staff would normally be available to interpret any user problems. However, it should also be pointed out that such access would impose additional costs for documentation and advisory services. These additional costs would be passed on to the user, and may act as a deterrent in some applications.

It was pointed out that the technical complexity of providing these services should not be underestimated, and that there could be no assurance of success in attempting to provide any of them. Moreover there are some reasonably stringent criteria which must be met by the network before any of these services would be of interest to the universities.

3. Criteria for Use of a University Computer/Communications Network

University staff suggested that the following criteria had to be satisfied before a computer/communications network would be of interest:

- It should be less expensive to use than the in-house facility;
- it must be as reliable as the in-house facility (90-95 percent up-time);
- it must provide easy access and retrieval of data;

- there should be adequate participation by the universities in the network in the form of equity;
- there must be a capability for handling large "number-crunching" jobs;
- there must be a set of useful programs on the other computers in the network which are less expensive to use at their home locations than if used after transfer to an in-house facility;
- program compatibility must be assured for distribution of peak-loads; and
- the network must have built-in redundancy.

It was also noted, first, that if spare capacity existed on an in-house system, it would be used in preference to other network facilities, even if all of the above criteria were met. Second, it was recognized that a substantial amount of preliminary work was necessary before the foundation could be laid for meeting these criteria. One university considered that the paucity of the technically competent personnel in the field of data network communications was an important point that should not be overlooked, as progress in this area will depend on their availability.

4. Role of the Federal Government in the Development of Computer/Communications Networks

It was generally acknowledged that the federal government has a continuing and important role to play in ensuring the orderly design, development and operation of computer/communications networks in Canada. In conjunction with the development of a university network, it was felt that the government should encourage the establishment of basic standards for network design, revamp its computer funding policies and procedures to support network research and development, and draft legislation to provide adequate safeguards against the abuse of personal data.

Some basic standards are required before any substantial progress can be made in network design. Hardware interface specifications must be developed which will allow any university to join the network, by adding its own computing facility and/or terminal devices. The universities indicated that, in their view, the federal government could play a useful role in co-ordinating their efforts to establish common hardware interface specifications which would be compatible with other networks being planned. In addition, the usefulness of the network would depend to a large extent on the ability to make use of other computers and data banks connected to the network through communications links. This implies the need for certain standards which do not currently exist. For example, the present lack of standard program cataloguing procedures will make it difficult to off-load work onto another network computer of identical model number and size. Similarly, non-standard approaches to coding personal identity and of storing commonly used data fields will make accessing and updating files on remote data banks complex and error-prone.

Apart from the direct NRC support of university computer centres which has now been effectively discontinued, the government provides university research funds from about forty different federal agencies. While not all research involves computers, a growing percentage of the projects require access to computing facilities or are directly involved with research in computers and their use. With the recent interest in computer networks, research and development work in the use of computers is likely to increase substantially.

The present system of government funding works well as long as the research work is clearly of direct interest to one or more federal funding agencies. However, research in the use of computers involves not only the technology of computing and communications, but also the particular discipline to which the use is directed. Some academic staff working on non-scientific applications of computers have had difficulty securing support for their research from the federal agencies in their discipline. These agencies argue that the project involves expenditure on computers or communications, which should be supported by a scientific agency; the scientific agency argues that the application area is not scientific and is therefore outside their area of interest. This situation results in much valuable time being spent trying to find the right people to approach in the federal government for research funding of these projects. The universities' view is that there should be a focal point in the federal government to which they can refer, for financial support and for interdisciplinary research in computers and their use.

There are a number of current data security problems which the universities feel may become more acute with the use of networks. Generally speaking, they are against any general restrictive measures which may, for example, curtail their access to scientific or technological data in the U.S., or prevent them from making the results of their research generally available. At the same time, they see a real need to provide adequate safeguards against the misuse of personal data which will be available on an increasing scale from social science research projects. The possibility of abuse is compounded by the ease of access to much larger quantities of data through a network. The universities recognize this is a vital area of concern and feel that the federal government should monitor the situation to ensure that the design and operation of networks incorporate the necessary safeguards.

There appear to be signs of developing interest in the types of services which might be provided to universities by computer/communications systems. Many computer centre directors have given considerable thought to the possible usefulness of a network, the criteria it must meet, and the government policies needed to support its orderly development. However, most universities still speak about networks with some caution because of their basic lack of confidence in government's present ability to cope with such a complex issue and some, perhaps, because of a fear of erosion of local power and flexibility. In addition, they are genuinely concerned about the scale of technological and administrative problems the network concept may present. However, the recent formation of the CANUNET Advisory Committee, under the sponsorship of the Department of Communications, indicates a willingness on the part of the universities to at least study the feasibility of a university network. Appendix B describes the conceptual framework within which the CANUNET project is being developed.

Part B

Special Systems

While the investigation of special systems at universities was directed to those which might meet a social need, this requirement was interpreted in its broadest sense and, in fact, any special system of note has been included in this study. This section identifies the major current application areas and the factors affecting their growth, including the influence a network might have on their development. Special systems can be divided into three main types.

1. Data Bank Systems for Analysis Purposes

Much of the special systems work done at universities falls into this category. Typically, a researcher collects data to be used in aggregate for a specific investigation which in many cases is of no continuing interest to himself or other researchers in his field. In any event, because the collection of meaningful data is such a significant part of any research work, the researcher is reluctant to share his data until he has exhausted all their potential for analysis. Under these circumstances the concept of providing general access to these types of data via a computer/communications network is of little relevance. On the other hand, these researchers are often users of data which have been collected and stored by government agencies. In this regard, computer/communications networks could play an important role in providing improved services from government data banks.

The university departments most active in this area are Medicine, Sociology, Psychology, Environment, Civil Engineering (Transportation), Economics and Schools of Business. They tend to be users of Statistics Canada and provincial government data but in some cases are developing their own data banks. The general consensus is that Statistics Canada services to non-government users require some changes. It was suggested that special utilities which re-format government statistical data for specific uses, similar to the econometric utility developed by private business in the U.S., would better meet the needs of these researchers. Among those developing their own data banks, the Institute for Behavioural Research at York University is probably one of the largest and most advanced in this area. Its aim, with the help of the Social Science

Research Council, is to become a major data bank centre for research in the social sciences.

2. Data Bank Systems for Reference Purposes

The data bank systems for reference purposes have a potential for wide application through computer/communications networks. These systems typically allow a user to search for a specific item of information or to add a new item of information to a file. They tend to hold information that is public and therefore do not require intricate safeguards for privacy and security purposes. Universities are usually co-operating with a federal government agency in the development of data and programs for these systems. This is perhaps the most important type of specialized system in that it covers both social and environmental services and is of general applicability across Canada. Areas of major development are as follows:

(a) Library Systems

Nearly every university visited has some form of an automated library system. The first step has usually been to automate the circulation system. Ultimately they hope to have their complete catalogue of books on random-access mass storage, but the cost of doing this is currently prohibitive.

Some of the operationally advanced systems are at Guelph, Saskatoon and Simon Fraser and one of the most complex at the University of Toronto. Total estimated investment in library systems at universities is $10 to 15 million. Total estimated annual costs are $5 to 10 million. There appear to have been few attempts at justifying the cost of these systems, and the co-operation among universities in developing library systems has been limited. Growth is being impeded by budgets and the high cost of getting large libraries catalogued in machine-readable form. The availability of a network could allow rationalization of libraries (in a region) through a more extensive and efficient book exchange system.

(b) Legal Systems

There are two legal information systems in Canada which are well advanced at the University of Montreal (DATUM) and Queen's (QUIC/LAW). Apart from certain differences in conceptual design and different data bases, the objectives of the two systems, namely to provide lawyers with rapid access to legal documents, are essentially similar. Total estimated investment in these systems to date is $2 million, with an annual investment level ranging from about $300,000 to $500,000 for each of the two systems. If such a service could be provided at a reasonable cost, the availability of a network could make it attractive to lawyers throughout Canada.

(c) Student-Guidance System

One of the more promising educational projects under development in Ontario is a student-guidance system. From a terminal located in his school or university a student can browse through a data bank on careers and the courses required for their undertaking. These types of system are in the development stage and will initially serve only a single province. The service will probably be offered from one or more locations, depending on communications costs.

(d) Survey, Mapping and Land Titles System

One of the most significant systems under development in Canada is a project to computerize the land titles for Prince Edward Island and New Brunswick under the auspices of the Atlantic Development Board. The system for Prince Edward Island is running and New Brunswick's should be partially operational in one year. Phase II will include assessment, Phase III community planning (health, water, sewage), and may be further extended to include socio-economic and environmental data.

The University of New Brunswick Computing Centre was responsible for the systems work and the New Brunswick Department of Natural Resources for the applications programming.

There has been about $1 million invested to date with an estimated budget of $200,000 per year. The system is expected to have a beneficial effect on industrial land development in the maritimes. Current legal fees for a title search are between $120 and $180. Searches on this new system should not cost more than $5, so one would expect a significant reduction in the legal fee. The system appears suitable for installation in other provinces; documentation is reasonably complete and implementation time is estimated to be three to four months. Growth of this project is dependent on government funding. The availability of a network within a province may make the service more attractive to lawyers and municipalities.

(e) Soil Data System

Under the auspices of the provincial and federal Departments of Agriculture, and co-ordinated by the Canadian Soil Survey Committee, work is progressing on the classification of soil types across Canada. A data bank is being developed for analysis, classification and model building of soil types for specific use (*e.g.*, sewage, highways, building, farming, etc.). Investigations are being carried out to see if data on climate and productivity are tied to soil regions. This project is currently on a limited budget and is therefore not progressing very quickly. A network could eliminate a considerable amount of duplicated effort across Canada in the process of classification.

(f) Geological Data System

There are currently over one hundred machine-readable geological data files in Canada developed to provide an inventory of mineral deposits for national resource management. The geological field is well advanced in the standardization of data storage and retrieval techniques which are co-ordinated through the Canada Centre for Geoscience Data in Ottawa. Self Adapting Format Flexible Retrieval and Storage System (SAFFRASS) has been developed at the University of Western Ontario to allow any geological data file owner to access his file from a computer. In May, 1971, there were six installations using SAFFRASS and nine more were expected by year-end, 1971. Because of its generality, SAFFRASS can be used for other information retrieval applications and is being implemented at Colorado Springs and

University of Western Ontario libraries. A retrieval of average complexity from a two million character file, which would normally take a trained geologist six weeks, can be done in ten minutes at a cost of about $4.50. The availability of a network would not be likely to have any impact on this project.

(g) Archeological Sites and Museum Holdings Data Bank

Work in this area has begun at the University of Windsor. The intention was to install, at no cost, a software package called GYPROS, developed by the Museum Computer Network in the U.S. They hope to encourage all Canadian universities and museums to record their holdings on this data base and to make use of it via mail or terminal services. The Royal Ontario Museum apparently examined the possibilities of becoming a member of the network, but decided it was too expensive. The availability of a network will be of questionable value in providing the level of service required.

(h) Medical Information and Statistical System

This system, operating at McMaster University, allows persons without computer expertise to enter data in a prescribed method and to select and analyze the data in a variety of ways. There are about one hundred projects on the system now. It may prove to have general usefulness in social science fields. Development of the system is dependent on a two-year grant from the provincial government. The system could be made more generally available through a network, or by transferring it to other computer centres.

(i) Financial Data Banks

The most highly developed financial computer services in Canada are provided from the Financial Research Institute in Montreal. The Institute provides services for financial analysis, economic analysis and portfolio management to banks, brokerage houses, trust companies, insurance companies, mutual funds, government institutions, industrial firms and seven universities. The service is provided via terminals from the McGill University Computing Centre, and reportedly accounts for approximately 30 percent of the Centre's revenue from the sale of services. A computer/communications network could make this type of service more economic and easily available to a wider spectrum of users.

The "reference" characteristics of all these systems tend to suggest that a generalized conceptual approach to design may be appropriate. Some systems which have already been developed may be applicable not only in the same discipline in other geographical regions, but also in other "reference" related disciplines. These systems are basically data resources and, as such, may serve the public best from regional or national data centres. Where rapid response is warranted, data network services will be useful. However, it is evident that in many cases the need for rapid response to an enquiry will be difficult to justify, and mail service would be the common mode of communication.

3. Systems with Unique Data Gathering or Computational Requirements

Unlike the reference data bank systems, these systems are not a data resource but rather provide a specialized, often complex computational service. They tend to suggest the use of a network to make their services more widely available, because of the difficulty in staffing new centres with the required specialists and the high cost involved in duplicating a complex facility.

(a) Real-Time Medical Systems

There are four major medical research computing centres in Canada at Dalhousie University, University of Toronto, University of Manitoba and University of Alberta. The investment to date at Manitoba, Toronto and Dalhousie is about $2 million with an annual budget of about $1 million. All systems perform a range of real-time, on-line and batch services for research. The systems are potentially capable of providing EEG and ECG analysis to hospitals in a large region using communications facilities. In this regard a network would be desirable as the response time is reasonably important. These projects depend on government grants, although the University of Toronto is attempting to become self-sufficient. While these systems are essentially research-oriented at this time, some will be extended to provide more general hospital data processing services similar to a pilot-system currently under development at the University of Sherbrooke. Here, fourteen hospitals are being included in a common computer system which will perform lab tests, medical record analysis and business data processing. The project is funded by the Quebec Department of Social Affairs, with a budget of $1.5 million/year. A similar project is under development at the University of Saskatchewan by the Hospital Systems Study Group.

(b) School Time-Tabling

Several universities have developed classroom time-tabling systems of varying degrees of sophistication. This is a service which could be made more widely available to universities and schools. Some Departments of Education, notably in Ontario, are already providing a service to a large number of schools. There is no technical reason why this service could not be offered to every school in Canada. The limitation at the moment is a shortage of trained representatives to explain to the school teachers how the system works.

(c) Geodetic Survey System

A satellite positioning method has been developed for geodetic surveys in the remote Canadian Arctic and along the Eastern Continental Shelf. The work has been a joint project of UNB, Bedford Institute and Shell Oil. Data obtained from satellite fixes are sent to a computer for validation and complex correction calculations. Investment to date is about $100,000, with an annual budget of $75,000. Canada is currently spending $500,000 per year to complete a northern survey and there will be a continuing need for surveys over the continental shelf. Communications could play a role in transmitting data to and from computation centres.

(d) Computer-Aided Learning Systems (CAL)

CAL is most active at Simon Fraser, Alberta and Western Ontario, where total investment to date is about $1 million with a total annual budget of $500,000. CAL services are satisfying a need for augmented learning facilities. Current operating costs run between $1.50 and $5 per student hour. NRC are working on a common CAL language and are hoping to establish a network. The potential for CAL is enormous if the cost per student hour can be lowered to the point where school-boards and post-secondary institutions feel they can afford a commitment to the concept. The major impediment to development is the lack of course authors, followed closely by funding.

(e) Fire Weather Index System (FWI)

The Fire Science Centre at the University of New Brunswick (UNB) has developed a computer model for the computation of the FWI from Temperature, Relative Humidity, Wind and Rainfall data. The application provides valuable information to the forest service, industry and the public with regard to the level of fire hazard in forest areas. In 1971, basic data compiled from 177 stations in the maritimes, were transmitted from the Halifax weather office by TWX to the UNB Computer Centre for computation of the FWI forest areas twice daily. The results were returned to the Halifax weather office and distributed to the press and radio. In 1972 the service is to be repeated, but may be expanded to cover two or three times the present area. The availability of a computer/communications network could allow one computing centre to calculate the FWI for the whole of Canada.

These computational systems could be made available to a broader user population by two methods: either by locating duplicate systems in other geographic areas or by providing access to the central system through communications facilities. The choice will be a function of cost and staffing which may be different for each system, and which will also be dependent on consideration of regional priorities.

Appendix A

Universities Included in Survey[1]

	Full-Time Students		Full-Time Students
Alberta	17,342	Ottawa	7,200
British Columbia	19,580	P.E.I.	1,566
Carleton	7,139	Quebec	7,255
Dalhousie	4,831	Queen's	7,519
Guelph	5,921	Saskatchewan	13,338
Lakehead	2,364	Sherbrooke	4,135
Laurentian	1,778	Simon Fraser	4,365
Laval	10,372	Sir George Williams	5,919
Manitoba	12,592	Toronto	21,134
McGill	14,754	Victoria	5,239
McMaster	6,924	Waterloo	10,299
Memorial	5,157	Western Ontario	10,698
Montreal	13,062	Windsor	5,020
New Brunswick	4,806	York	7,734

	Number	Approximate Full-Time Students	Percent
Universities contacted	28	245,000	85
Other Universities and Colleges	35	45,000	15
Total	63	290,000	100

[1] Data obtained from Association of Univerisites and Colleges of Canada 1971 Handbook. Enrolments refer to 1969-1970.

Appendix B

Trends in Usage at University of Toronto Computer Centre

Percentage of Time Used	**1968**	**1970/71**
Physics	21.1	16.9
Chemistry	29.0	10.4
Department of Computer Sciences	4.6	7.5
Medical	2.8	6.0
Electrical Engineering	2.6	5.2
Civil Engineering	2.2	3.6
Social Science & Other	37.7	50.4
	100.0	100.0

Appendix C

University Commercial Computing Services

1. Introduction

A number of submissions from data processing service bureaux to the Task Force objected to the provision of commercial computing services by universities. The Task Force therefore undertook to assess the dimensions of the problem and requested information on university commercial services from both the commercial service bureaux and the universities.

This report summarizes the information from these sources and considers the implications of university commercial services. The following summarizes information contained in replies received from twenty-six universities across Canada in response to questionnaires sent by the Task Force:

- The total 1970-71 commercial revenue from computing services of the twenty-six universities included in the sample was $1.5 million;
- this amount represents a national average of approximately 1.3 percent of the total commercial service bureaux revenues, estimated at $114 million;[1]
- the four largest university revenue producers accounted for almost $1.1 million of the $1.5 million total;
- growth in university commercial revenues from computing services has averaged 10 percent per annum over the past two years;
- these revenues were derived primarily from computer time sales with small contributions (a total of approximately $54,000 in 1970-71) from programming and system software development;
- seven out of the twenty-six universities reported little or no commercial activity;
- ten stated that they provided services to the combined value of about $540,000 in 1970-71, but pointed out that such services were not available from commercial sources in their area;
- the remaining nine universities indicated that their commercial computer services, totalling some $950,000 in revenue, could have been provided by local service bureaux. Of this last group, four ou of the nine accounted for $850,000 of the revenue;

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[1] A service bureau estimates that universities account for about 18 percent of the business in the Montreal area

- in 1971, three universities reported profits from the sale of computing services ranging from $3,000 to $75,000;
- during the same period only three universities reported having staff with specific responsibilities for commercial customers (there was one person on half-time in computer operations at each facility);
- none of the respondents indicated the possession of a formal marketing organization for computer service.

2. Criticisms of University Commercial Activities

Concurrently with the Task Force questionnaire to universities, The Canadian Association of Data Processing Organizations (CADAPSO), which represents eighteen of the service bureaux operating in Canada, carried out a survey of its members to ascertain particular concerns respecting the commercial activities of universities in the computer service field.

The CADAPSO survey identified McGill as the major provider of commercial services, and evidence was produced to indicate that its charges were lower than those of commercial bureaux. Another large purveyor was the University of Manitoba, which, it was claimed, actively solicited work from the private sector, as well as from government and public institutions[2]. Other universities identified in the survey as offering commercial services were McMaster, University of Montreal, Brock, Simon Fraser, University of New Brunswick, University of British Columbia and the University of Ottawa. In addition, some concern was expressed with regard to faculty at the University of Alberta offering consulting services with their computing requirements being satisfied on the university computer[3]. The same concern was expressed with regard to faculty at the University of Toronto, together with the fear that the computer centre there may re-enter the market if a larger computer system under consideration is obtained.

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[2] The University of Manitoba disputes this claim in a letter to the Task Force, dated July 25, 1972. While this was true [in 1969], since that time the University has not solicited any work from business or government. Our current policy is to supply computer time to government and public institutions if they cannot find suitable alternative services in Winnipeg."

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[3] The University of Alberta Computing Services states, in a letter to the Task Force, dated July 24, 1972, that all commercial computer work is billed at 200 percent of break-even rates and the University has a policy that all commercial work must be billed at a rate in excess of services commercially available"

The major complaints levelled by CADAPSO against university activities in the commercial field were:

- The university computer centres are in a privileged position in that (a) equipment is exempt duty and sales tax; (b) income from commercial services is not taxed; (c) major overheads are covered and skills and services are provided by the university at less than commercial costs; and (d) at least one equipment supplier offers an educational discount (but requires reimbursement on a *pro rata* basis for computer time used for commercial purposes).
- The university computer centres use this privileged position to offer services at rates lower than commercial service bureaux can afford to charge.
- CADAPSO members expressed a fear that an extension of these services would result in an increase in what they consider to be unfair competition. It should be noted that this concern has been intensified by the elimination of direct NRC support of university data centres, and other sources of funding, which may well force universities to seek new avenues for funding.

3. The Universities' Viewpoint

- Some universities stated that they set their commercial rates higher than the service bureaux, presumably to discourage commercial users, and to avoid criticism from the private business sector.
- Other universities charge commercial users anywhere from 20 percent to 40 percent more than their internal rates, which have been established on a cost-recovery basis.[4]
- In certain cases, at least, university faculty members who use the computer for outside consulting work are billed at the same rate as commercial customers.
- The major source of university computing income is claimed to originate from applications in the scientific and engineering fields, where the universities can provide access to programs not often available at commercial service bureaux.
- There may be a few instances where, because the university computing facilities are adjacent to certain commercial enterprises or institutions, the convenience has prompted these organizations to request services from the university, rather than to seek them from commercial service bureaux more distantly located.
- Commercial applications run on university computers can be of genuine educational value. Direct student contact with business and industry enables academics to

[4] Service bureaux raise the question as to whether costs in this context include only operating costs and ignore all the important overheads.

structure practical experience with the commercial business world into their course material.

- In some instances, it can be argued that the university is in a position to provide services to the community which may be socially desirable but not commercially attractive. These include services to municipal recreational activities, charitable agencies and the like. In this sense, university computing centres play an important role in the development of special computer systems, serving social needs.

4. Other Complexities

Many universities are conscious of the criticisms of commercial computer activities made by service bureaux, and have avoided any direct competition. There are, however, a number of factors which tend to draw the university computing centres into the commercial field:

- *Increasing demands,* in both teaching and research, result in the acquisition of larger computer installations by universities. In some cases, the new installation may not initially be used to capacity and there is a temptation to sell the excess capacity in the commercial field, to help defray the increased cost of the new equipment. One approach which has been suggested would be a greater use of shared facilities by using data communications for access to other university centres. Another possible solution might be to encourage university use of local commercial facilities.
- *In areas of low industrial or commercial activity,* where there is a lack of commercial data services, the universities provide a very valuable service to local business interests. Such situations, which are essentially regional in nature, require a co-ordinated approach by federal and provincial authorities. It is not logical to deny business concerns access to computing capacity. Yet, if universities in such areas continue to supply business needs, there will be no incentive to establish commercial service bureaux. This could further aggravate the lack of regional development.
- *A natural affinity exists between universities and non-profit organizations,* involved in research activities. These include, for example, the Financial Research Institute of Montreal, where the arrangement with McGill University is a particular source of concern to commercial service bureaux. It is often difficult to define a cut-off point where a specific research project has developed from one which is basically research-oriented to one which is primarily production-oriented. When the project has reached the production stage there is a case for considering use of commercial facilities.

- *Highly marketable software packages* have been developed as by-products of university research. A good example of this is the development of the WATFOR and WATFIV compilers by the University of Waterloo. It would be highly undesirable to attempt to decrease university activities of this type, even though such by-products are commercially marketable.
- A number of *government organizations* feel that, as governments provide grants which pay for university computer centres, they should be permitted to take advantage of lower rates available from universities, rather than paying the full rates at commercial service bureaux.
- *Provincial jurisdiction* over university affairs has been implied in this report, but provincial reactions to the various issues have not been explored.

Appendix D

Canadian University Computing Network (CANUNET)

The concept of the CANUNET project is to make the computing resources of ultimately all Canadian universities available, through telecommunications links, to all students and scholars. This report describes some of the major developments of university networks in Canada and other countries. It also provides details of the conceptual framework within which the CANUNET project is being developed and outlines progress in assessing its feasibility.

1. Background

Recently a significant interest and involvement in university computer networks has developed both in Canada and abroad. The impetus behind university network development comes from three main sources: a growing requirement by university staff and faculty to have access to programs, computers, or data bases at universities other than their own; the pressure on educational budgets and the consequent desire to find some means for rationalizing educational computing requirements; and a general recognition that before public computer networks come into being there must be a considerable research and development effort, an activity in which the universities could play a significant role.

There are already several regional computer network projects under development for universities in Canada. The Computer Coordination Group of teh Council of Ontario Universities is working on a network to link six Ontario universities. A design plan was to have been submitted for budget approval in February, 1972. Initial estimates indicate that the project will take two to three years to complete at a cost of $2 to 3 million. The operating costs are to be about $6,000.00 per month for each university on the network.

The CESIGU *(Comité d'élaboration d'un système d'informatique et de gestion* *des universités)* project is studying the possibility of developing a network for Quebec universities. Emphasis in this project is on a common administrative data processing system for these universities, with each university developing a different part of the system. It is anticipated the project will require $10 to 15 million over the next five years.

In addition to these two major projects, there are at least four other areas of the country where university networks are being discussed and developed. For example, Saskatchewan is studying a regional computer network, and has the Regina and Saskatoon campus computers linked and operating in a network mode. Both Alberta and the maritimes are in the early stages of discussion on local university networks. Alberta is currently studying the educational computer needs for the province and some form of co-operative development is being considered. The maritimes, which expect to unify their university granting structure in the summer of 1972, will undoubtedly be considering the possibilities of a university computer network in the context of the general plans for rationalizing computing facilities throughout the region. In Quebec, a network of remote batch terminals serves the various locations of the *Université du Québec.*

Significant university computer networks are also in operation or under development in other countries. For example, the ARPA (Advanced Research Projects Agency) network in the U.S., which connects more than twenty university computers at different locations across the country, is at a stage where the possibility of commercial operation is under investigation. In Europe, plans are being discussed for an ARPA-like network to serve the common market countries. Britain is taking active measures to control the expansion of most university computing facilities and is planning to offer network services. Also in France, a network which will connect four universities is due to be operational in 1972.

These developments in the university environment complement and support the growing body of opinion that anticipates the construction of major national computer networks in the forseeable future. The Department of Communications, recognizing the importance of the universities in this development, has encouraged these institutions to consider the construction of a national university network. The reaction from the universities has been favourable, and in March, 1971, the first meeting was held between representatives of the Department of Communications and the universities to formulate a broad approach to the development of a Canadian University Computer Network.

2. CANUNET

(a) Concept

The Canadian University Computer Network, in its ultimate configuration, would provide students and faculty on every campus in Canada access to the information processing capability and data banks at all Canadian university computing centres.

This broad concept of the network suggests certain general design criteria which must be met. The network must:

- Be capable of accommodating large and medium scale computers of different makes;
- be open-ended and capable of accommodating all Canadian universities, and commercial services purchased by the university;
- function over telecommunications lines of various speeds as expansion and traffic requirements dictate;
- be transparent to user terminals;
- use existing computer/communications facilities as much as possible.

(b) Benefits

The benefits of a Canadian University Computer Network could include:

- *Reduction of regional differences in computing services available at Canadian Universities.* By providing access to any university facility in the country, the network would make the same computing resources available to every student and faculty member irrespective of his location or local computing capability.
- *Access to specialized data banks at other locations.* The network would make specialized data banks, such as the proposed NRC bank of scientific and technical information,

or the legal data banks of Queen's and Montreal, available on a more economical basis than is currently possible to a larger community of scholars.

- *Better utilization of university computers.* A computer/communications network could provide universities with access to a computer on a shared basis. Rather than acquire a larger computer, when its existing equipment is operating at full capacity, a university could use the shared computer until its usage had built up to a point where a new acquisition was justified. The network may also allow access to spare capacity for handling peak loads, either on non-university computers or on university computers operating in other time zones. Both alternatives should have the effect of extending the useful life of university facilities.
- *Higher degree of specialization and efficiency.* Computers differ in their suitability for various tasks, but if a number of different computers were available in a network, each one might become more specialized in its work and a higher degree of efficiency could result. Further, complex systems of programs require teams with specialized technical and programming knowledge if they are to be properly maintained and effectively operated. Most universities cannot afford a complete complement of specialists for all services. With a network, however, it would be possible for different universities to specialize in particular types of services that would then be made available to all other universities.
- *Opportunities for new applications.* The network could provide a facility for the development of inter-university applications, such as a Canadian Universities Library System, shared research programs, remote teaching and decentralized computer-assisted instruction.
- *The development and training of personnel.* If Canada is to develop large-scale national systems, a supply of highly-trained personnel must be available. The universities participating in the network could provide the necessary training staff and facilities.
- *Research and development experience.* Canada needs to gain practical experience on a broad scale in building and operating computer networks. A university network could provide a natural medium for conducting experiments and gaining experience that would be valuable in the development of future computer networks.

These are the major benefits expected from a network. However, as there are no fully operational national university networks at present, the extent to which the benefits to universities are real or achievable is somewhat speculative. Nevertheless, the research and development experience that could be derived from projects like CANUNET is vital if Canada wishes to develop her own capability to build and operate public computer networks in the future.

3. Development Program

At the initial meeting of federal Department of Communications (DOC) and university representatives in March, 1971, agreement was reached on a continuing development program leading to preparation of a master plan for a Canadian University Network. As a result, a contract was signed with the University of Quebec for $75,000.00 of DOC funds to act as the focal point for the development of the CANUNET Master Plan. The entire program operates under direct DOC supervision, but the department is advised by an advisory committee comprising representatives from all participating universities, NRC, Science Council, Department of Industry, Trade and Commerce, Secretary of State and the Association of Universities and Colleges of Canada, as well as DOC. At the time of writing there was no participation by the communication carrier organizations in planning and development of the network.

The program for the Master Plan has been divided into seven stages:

- Investigation of the present situation and compilation of relevent documentation;
- development of concepts and guide-lines for the network;
- definition of the message format and the telecommunication protocol, including the necessary network control;
- evaluation of alternative institutional arrangements, *i.e.*, management stucture for operation, network financial arrangements, and rules for participation;
- definition of the modalities of the implementation;
- preparation of estimates;
- identification of sources of financing.

The Advisory Committee has established sub-committees to work on four aspects of the project:

- *Communication Costs:* what will they be and how can they be most equitably shared?
- *Utilization of Network:* what are the problems for the user caused by different operating systems, languages, conventions, and packages, employed at the various computers of the network? How can these problems

be minimized so that users can be persuaded to take advantage of the network?

- *Network Design:* what are the hardware and software specifications of the network elements, and, in particular, the message format and telecommunication protocol?
- *Institutional Framework:* what are the appropriate management structures, financial arrangements, and rules for participation?

The sub-committees have prepared reports which form sections of the Master Plan. This was submitted to the Advisory Committee and has been published with the sub-committee reports annexed thereto. Upon approval of the plan it is expected that a number of Canadian universities, with appropriate experience and representing various geographical regions of Canada, will be commissioned to construct a pilot computer network. The development program would provide for the addition of other universities to the pilot network, as determined by the progress achieved, building up to a national university computer network.