A LOOK AT THE DALHOUSIE UNIVERSITY COMPUTER CENTRE

AND

THE QUESTION OF REGIONALISM

Dalhousie University
December, 1969

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

On November 13, 1969, Dr. Arthur L. Murphy, Chairman, University Grants Committee, wrote to Dr. J. J. MacDonald, Chairman, A. P. I. C. S. The letter was short but the message was unmistakably clear!

"The University Grants Committee has been gravely concerned for some years about the use of computers in our provincial universities.

"It seems to us that there is a lack of appreciation among most faculties as to the uses computers can be put to; a complete lack of co-operation among the universities with regard to the facilities available; and a failure to make use of the one large instrument available, that is the IBM 360/50 at Dalhousie.

"There is no doubt that a great part of the trouble lies in the lack of a common director or directing group for computer services, and the fact that an overall study of university needs has not been made by a competent, independent observer.

"The UGC therefore urges you, through the A. P. I. C. S. sub-committee on computers, to bring in as strong recommendations as you possibly can which may lead to the settling of the problem.....".

The work for the report which follows was undertaken several months before Dr. Murphy's letter to Dr. MacDonald. It is the direct result of pressure from the University Administration in response to a request from the UGC to ascertain the facts and define its program. The purpose was to be fourfold:

1) To assess the existing state of computer development at Dalhousie within the context of its relationship to other provincial universities.

2) To review the events which created the existing situation.

3) To suggest possible alternatives for improving the existing situation.

4) To provide a detailed simple explanation for interested staff and laymen explaining the function of the computer and computer centre.

At the outset, it was generally assumed that the patient was gravely ill, that only immediate and ruthless surgery would held. This has not proven to be the case. The patient is ill, but the illness is not now and need not become, serious.

We believe that much of the problem has been caused by the lack of careful analysis and interpretation accorded to much of the information which has been circulated, thus negating most of its relevance or usefullness. Two factors can be blamed:

1) the form in which the information was forwarded, and the difficulty of determining and including evaluative criteria on which to make judgements;

2) the considerable mystery which is attached by humans, at all levels of society, to those objects called computers.

1. INTRODUCTION

"Computers ... like the psychiatrist's ink blot, serve the imagination as symbols for all that is mysterious, potential, portentious. For when man is faced with ambiguity, with complex shadows he only partly understands, he rejects that ambiguity and reads meaning into the shadows. And when he lacks the knowledge and technical means to find the real meanings of the shadows, he reads into them the meanings of his own heart and mind, uses them to give external shape to his provate hopes and fears. So the ambiguous ink-blot becomes a mirror. When man describes it, he depicts not some external reality, but himself." *

1.1 What is a Computer?

Any mechanical or electronic apparatus capable of storing information which can be manipulated, modified or extended on the basis of programmed instruction is a computer. Speed and accuracy are the electronic computer's source of versatility. As an external coupling to man's mind, it has expanded his understanding in areas which might not otherwise have been possible.

Most computers are of one principal genre: the general purpose electronic digital computer. Until recently, general purpose computers were divided into two main types, business and scientific. A business computer was designed to perform a comparatively small amount of computing with large amounts of data. A scientific computer performed lengthy mathematical calculations using a relatively small amount of data.

The distinction between business and scientific computers is rapidly disappearing. The IBM System /360, for example, was designed to perform both these types of computation.

Although general purpose digital computers differ widely in size, form and method of operation, they have five features in common:

1) input - All have some device by which information is fed into the computer

2) output - All have some device by which information is fed out of the computer

* Simon, Herbert L., The Shape of Automation, 1967

3) arithmetic unit - All have some device where the operations are performed on the information brought into the unit

4) storage - All must have the capability of remembering or storing information in electromagnetic form

5) systems control - All must have a set of electronic circuits which automatically manage all the parts of the computer, causing it to follow the detailed instruction stored in it so that information is taken in, manipulated according to the stored program, and stored temporarily in the memory, while the results are transmitted through the output device.

COMPUTER OPERATION
/SCHEMATIC DIAGRAM

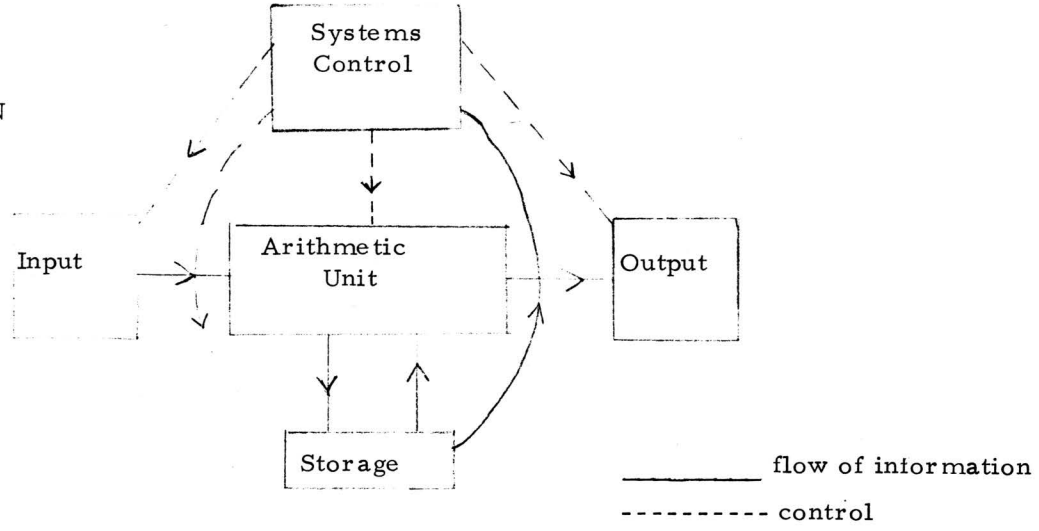


Figure I

NOTE: Information flows from the INPUT to the ARITHMETIC UNIT and from there to OUTPUT. Information flows both ways between ARITHMETIC UNIT and STORAGE. The SYSTEM CONTROL controls the operation of all parts and gets information from STORAGE.

1.2 What is a University Computer Centre?

More than the building in which the computer is housed and serviced, the computer centre is the sum of the policies, the procedures, the personnel, and the machinery available for providing computer service to its community of users. "To many, the availability of adequate computational facilities should be regarded in the same way as the availability of the telephone, or of water, or of electricity." * Computer centres come in many sizes, include a wide variety of computers and peripheral service equipment, but whatever the physical configuration, their aim should be to aid:

a) RESEARCH: Research projects are essential to the development of a good University's graduate and teaching programs. Experience indicates a wide range of benefits for communities located near Universities with active research programs. Modern research is dependent upon the computer as a research tool.

b) ADMINISTRATIVE TASKS: Increasing size and rising costs have made many aspects of administrative management control within Universities too complex for up-to-date, continuing, and accurate analysis utilizing traditional techniques. Program costing, inventory control, budget forecasting, student records, curriculum analysis, all pose enormous problems. Computers, through developed business programs and simulation techniques, can help.

c) EDUCATION:

1. Appreciation. The computers' impact on society is potentially enormous. Every educated person in the future will have to have a basic understanding and an appreciation of this potential and the computer's role in society.

* Porter, A; Hartle, D. G.; & Hull, T. C.; Computer Facilities in Canadian Universities, p. 3

2. Training. Computers are already widely used in the business, industrial and academic world with demand increasing. The pool of trained and skilled people who can operate computers, programmers who can use the computer, and systems designers who can develop applications must be expanded.

3. Teaching. Computer based systems which can become technological aids to the learner must be developed. This is a new and rapidly developing field which must be exploited.

d) SERVICE:

1. Analysts. Many users, including many who can understand and use computers, need expert advice as to the course they should follow in development of computer based systems which will satisfy their needs. Specialists must be employed to give guidance along these lines.

2. Information and publicity. The computer centre must continually publicise its activities and services to the entire community. This will increase interest, stimulate activity, and promote usage.

The wide range of service activities outlined above require a powerful computer and skilled staff. More important, they require a careful assessment of the needs of a given community of users.

1.3 What is a Regional Computer Centre?

A regional computing centre is foremost a service facility. Its sine qua non is to provide equal opportunity for use of a broad range of computer services, regardless of the size of the location of its users at an economic cost. A major factor in the design of regional computing centres is the distance between participating institutions. In Nova Scotia two regional concepts are possible. One which encompasses the greater Halifax/Dartmouth area,* and one which extends throughout Nova Scotia.

To fulfill such a requirement the centre must provide computer equipment and software capable of helping to satisfy all of the services outlined under Section 1.2. However, these services must be responsive to the differing requirements of all participating users. The schematic which follows illustrates the wide variety of interests which can be identified within a relatively small geographic area in Nova Scotia. Clearly, in the establishment of a regional computer centre, care must be given to the selection of the central computer, the computer programs developed, the staff employed, the policies and procedures which are initiated and implemented. Analysis of needs should be the final criteria. It is important to remember that regional centres do not have to be restricted to a specific type of institution.

* see appendix A for a Metropolitan Service Proposal

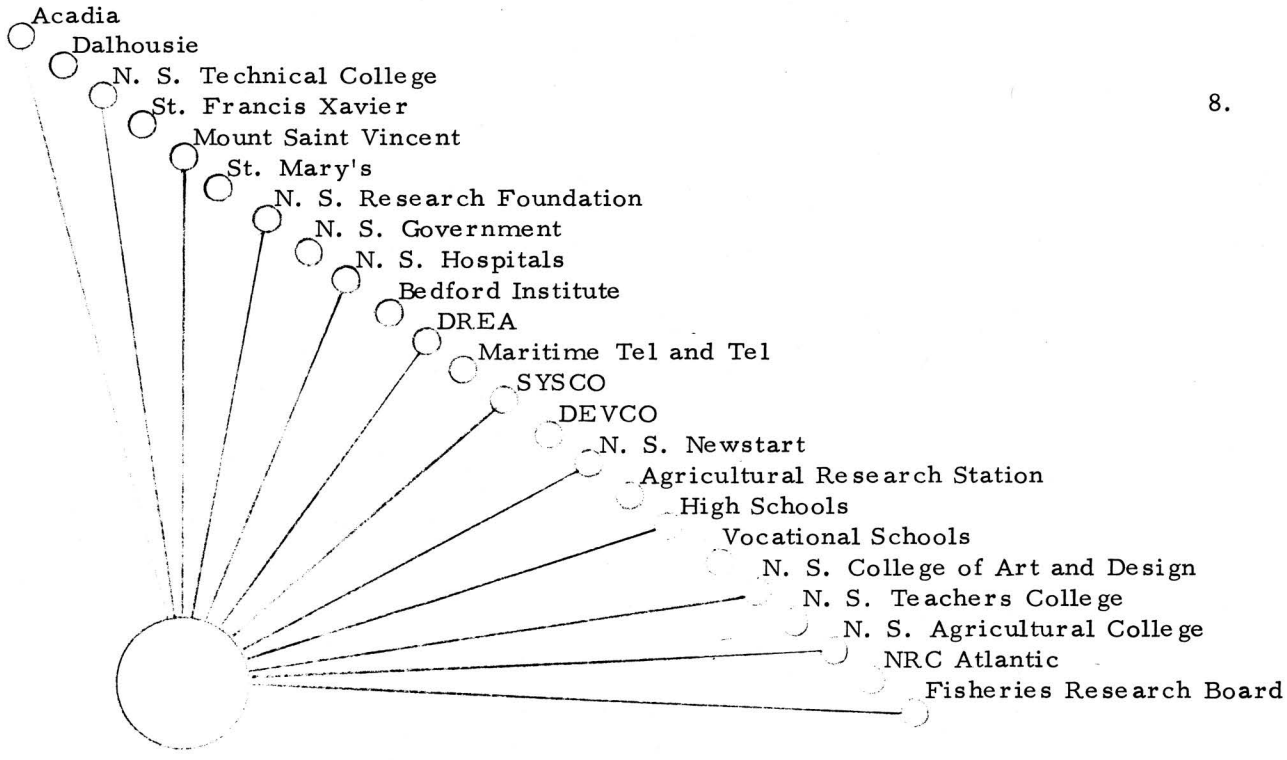


Figure 2

SCHEMATIC FOR A REGIONAL COMPUTER CENTRE

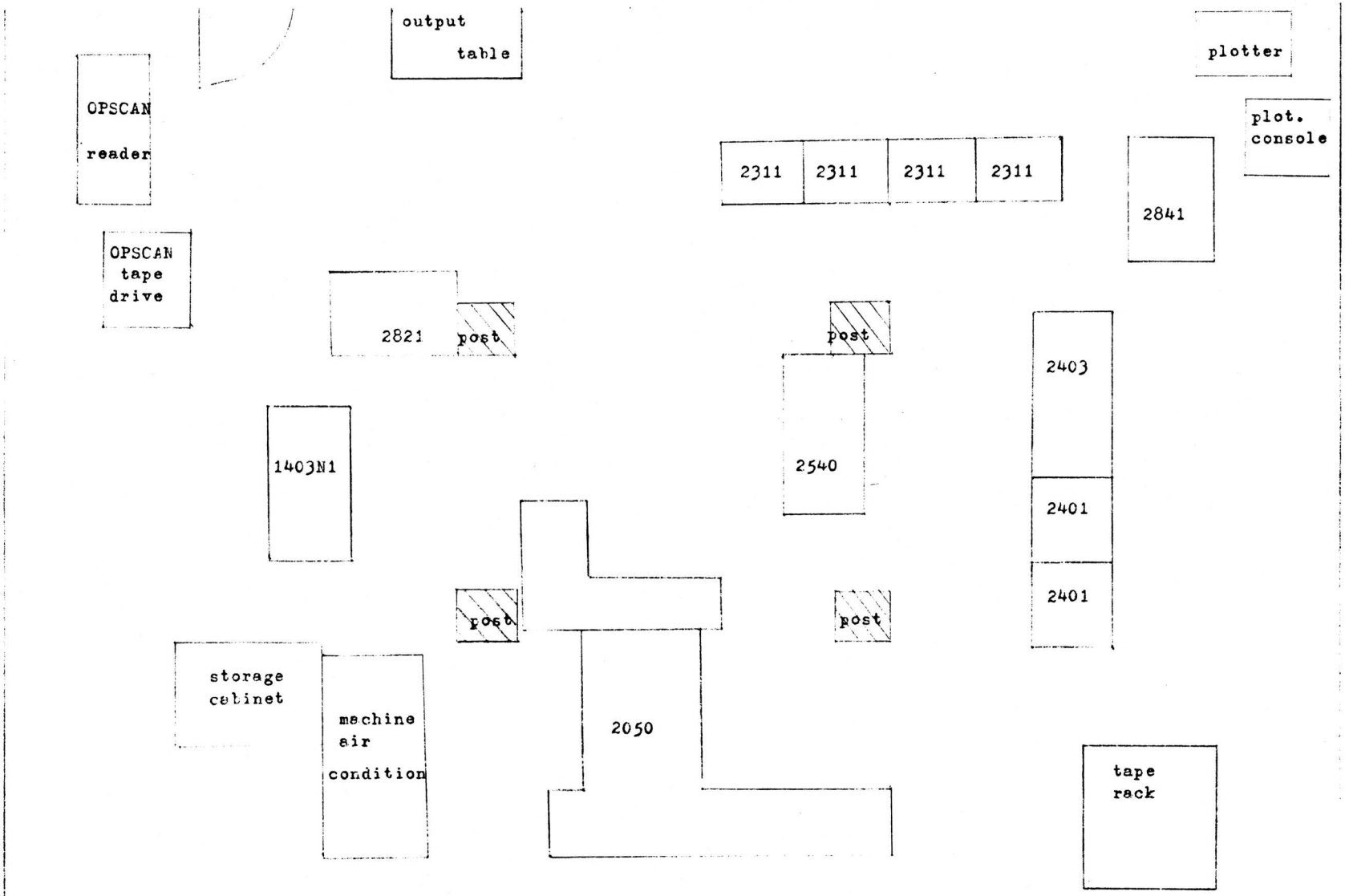
THE DALHOUSIE UNIVERSITY COMPUTER CENTRE

2.1 Description

2.1.1 Equipment and Physical Arrangement

The Dalhousie University Computer Centre presently occupies two temporary buildings on South Street, with the computing equipment located on the Studley Campus, in the Old Law Building basement. The physical resources of the centre consist of the following equipment diagrammed in Figure 3.

- 1 IBM 026 Printing Card Punch
- 20 IBM 029 Printing Card Punches
- 1 IBM 059 Card Verifier
- 1 IBM 1052 Printer Keyboard
- 1 IBM 1403 Printer
- 1 IBM 1416 Printer Train Cartridge
- 1 IBM 2050 Central Processor Unit
- 4 IBM 2311 Disk Storage Drives
- 2 IBM 2401 Magnetic Tape Units
- 1 IBM 2403 Magnetic Tape Unit
- 1 IBM 2540 Card Read Punch
- 1 IBM 2821 Control Unit
- 1 CALCOMP 565 Plotter
- 1 PDP/8 Computer and Console
- 1 PEC Magnetic Tape Recorder
- 1 Machine Air Conditioner
- 1 Card Storage Cabinet
- 1 Tape Rack
- 1 Forms decollator
- 1 Forms burster
- 1 OPSCAN 100 Optical Reader Tape Drive
- 1 OPSCAN 100 Optical Reading Unit
- 1 IBM 2841 Storage Control Unit


output
table
plotter
OPSCAN
reader
plot.
console
2311
2311
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2841
OPSCAN
tape
drive
2821
post
post
2403
1403N1
2540
2401
2401
post
post
storage
cabinet
machine
air
condition
2050
tape
rack

Figure 3

2.1.2 Equipment Systems

There are three systems in the Centre. The latter two are dependent on the IBM 360 and enhance its versatility by adding special capabilities.

1) The IBM/360 M 50
- provides digital problem solutions
- supports department research
- provides simulation capacity
- generates reports
- serves as a primary educational tool

2) The Calcomp Plotter
- plots graphs of complex functions
- provides visual report output
- converts paper tape data to magnetic tape form
- can be engineered for analogue-digital conversion

3) The Opscan Scanner
- stores optically marked information off line for later processing by S/360
- scores tests with a standard answer sheet

The remainder of the equipment supports the above systems. This configuration of equipment is considered the minimum for a research program such as that undertaken by a number of scientists at Dalhousie. The system is capable of expansion into a good regional service centre.

2.1.3 Administrative Arrangement

At Dalhousie, the Computers and Communications Services Committee is responsible for establishing all policies relating to the Computer Centre. The Chairman of the Committee is the Director of Communication Services. Its membership includes the Vice-Presidents, The Deans, and representatives from N. S. T. C. It could be expanded to accommodate representation from other universities, if a regional computer centre were to become a reality. The Director of the Computer Centre is the secretary of the committee. He reports to the Director of Communication Services and is responsible for:

1) Implementation for approved policies
2) Recruiting
3) Co-ordination of centre activities
4) Administration of the Centre
5) Budget formulation and planning
6) New policy recommendations

He is aided in these tasks by a Users Committee.

The Centre is divided into four functional groups. These groups report to the Director of the Computer Centre and reflect the diversity of services now offered. They include:

1) Operations Management Services
2) Programming Services
3) Information Services
4) Administrative Services

The duties of these groups are depicted in Figure 4. It should be noted that both the Computers and Communications Services Committee and the Users Committee are new. They were established in October of this year.

ADMINISTRATIVE STRUCTURE FOR COMPUTER SERVICES

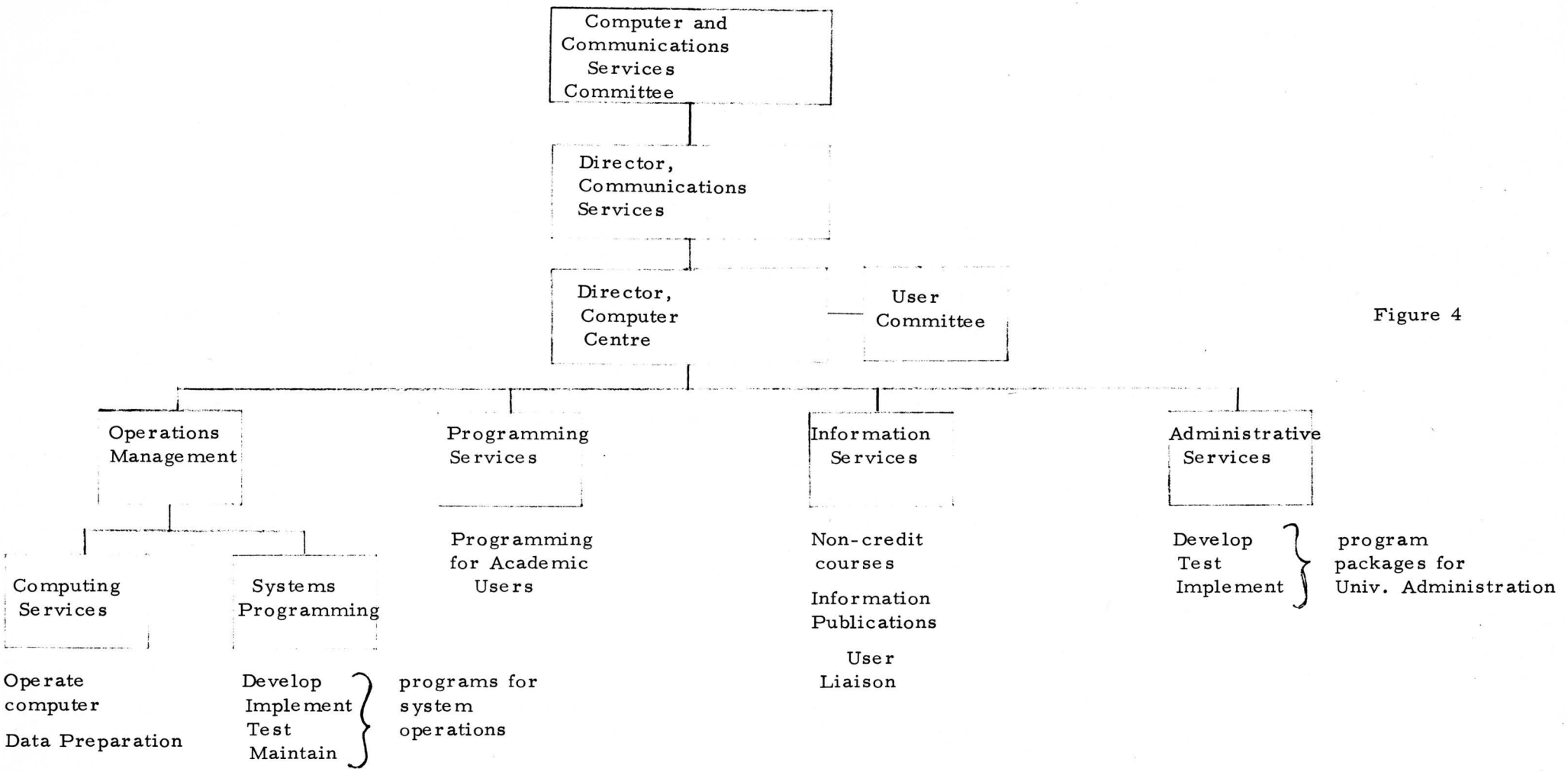


Figure 4

2.2 Present Program of the Dalhousie University Computer Centre

The first computer was installed on the Dalhousie campus in late 1962. However, it was not until January 1968 when the current System/360 Model 50 was installed that users had, for the first time, access to a reasonably powerful computer system.

Although the goal of the centre, from the outset, was to involve itself in providing computer services which would aid the research, education, and administrative needs of Nova Scotian universities on both a local and regional basis, it has not been as successful as some may have wished. Many factors can be cited. Of these five are worth noting:

1) lack of staff
2) lack of space
3) lack of funds
4) lack of work
5) lack of direction

All five of the above placed constraints on the Computer Centre's operation. Lack of space will not be a serious problem after the opening of the Izaac Walton Killam Memorial Library in the Spring of 1970. The others cannot be disposed of so easily. Since they are related, they will be examined under six other categories:

1) Use and justification
2) Research
3) Education
4) Personnel
5) Equipment
6) Publicity

2.2.1 Usage

One of the principal criticisms levied at the Computer Centre is that it is not working at capacity. Since computer services on the campus have been free of charge, this is an interesting phenomenon. According to a maxim of the computer world, "free unused computer time will be filled up rapidly, whether this use is justifiable or not". This has not occurred at Dalhousie. Instead, a large portion of unused time seems to remain. The question is why? There are many answers but the most significant probably lies in a point made by the Director in his report to the UGC in 1969:

"There is very much of a 'bootstrap' problem: the potential of the computer can only be realized by those who have developed or have been taught the skill of its use....."

Several points follow from the above:

1) The fact that Dalhousie has not utilized its computer resources 24 hours per day does not mean they have been misused or underused. Some of the scientific work which has been performed on the computer could not have been done in any other way or on any other computer in the area. These researchers would leave the area if the existing facility were unavailable. Moreover, it was never expected by those who established the centre that Dalhousie users alone should use 100% of the computer's available time.

2) The lack of trained operators in the initial stages of development, and trained users, system analysts, and systems designers, at all stages of the centre's development and growth has contributed to this problem and is an indication of the dearth of computer experience prevalent in Nova Scotia and another example of regional disparity.

3) The lack of usage by other institutions is explained, in part, by the general lack of computer skills in the province and by the fact that computer usage is highest in graduate applications.

Other factors have also contributed heavily to the problem. Two are worth underscoring:

1) Changes in the centre's personnel have lead to lapses in planning, and the University Administration has not until recently, developed comprehensive policy directives regarding the centre's operation or reorganization.

2) Effective institutional co-operative use in Nova Scotia has been hampered by the lack of a central directing group, conflicting policies, and a general lack of interest and direction. Many promising applications remain unfulfilled.

Nevertheless, substantial progress has been made and is increasing. There are currently 38 departments at Dalhousie using the system. Of these, 27 are active. Moreover, within these departments, there are over 200 research users and between 800-1,000 students will use the computer during the year.

IBM suggests that the currently installed system is meeting two standard guidelines normally found in university computer centres: namely, that the day's work should be completed in two shifts and that job turnaround should, normally, not exceed three hours. They further suggest that the current usage of around 275 metered hours makes it one of the most productive computers in the province. (see Table 1 and 2 for a summary of usage and users for June 68 through July 69)

Computer use for the past 19 months is graphed in Figure 5. It indicates a dramatic increase in usage over that period. If the estimate (extrapolated from an analysis of the growth pattern during the last 19 months) of an additional 50 metered hours per term continues, the present computer configuration based on a 16 hour, 7 day work week, will be saturated in another year. Further, this estimate does not take into account:

1) increases in administrative computing. At present, administrative usage is approximately 25 hours and is expected to double at least;

2) anticipated changes in the curriculum. The establishment of a Computer Science Department or the requirement of programming courses for all students would have a significant impact on computer usage;

3) growth in usage by outside users.

Finally, in assessing the figures provided by the graph, several additional facts should be kept in mind:

1) The operating mode (PCP) of the IBM 360 M50 allows it to service only one job at a time. External intervention is often necessary to complete a job. Any intervention causes the central processor clock to stop. Thus, computer hours reflect the time the central processor is in use and not the total amount of computer use.

2) Commercial timing estimates allow 25% of the centre's operating time for such jobs as mounting and demounting tapes, servicing interrupts, and setting up jobs, when the PCP mode is used. This figure should be added to the usage figures to give a more realistic figure.

3) If the work load increases, the work week could be increased by adding a third shift to the centre's operation. Although this would not increase equipment costs, it would add to the direct costs (heat, light, supplies, personnel, maintenance) thus increase the charges to the centre.

GRAPH OF COMPUTER USAGE BY MONTH
Dalhousie University Computer Centre

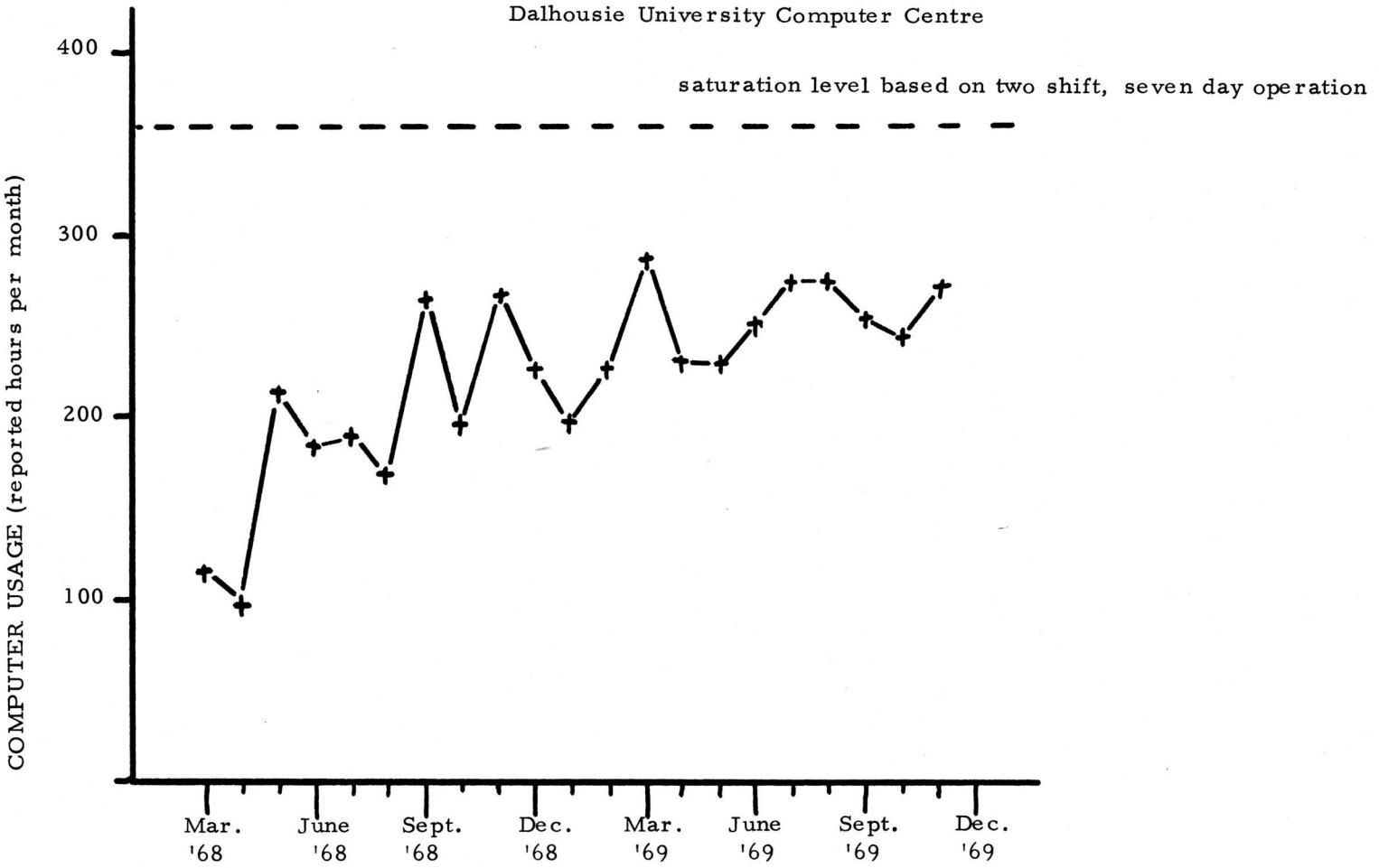


Figure 5

TABLE 1

Distribution of Use of the /360 Computer
July - October, 1969

Dalhousie University Computer Centre

	%	Hours Per Month
(a) Research supported by NRC operating grants	6	16
(b) Other research in NRC supported fields	20	53
(c) Research in other fields	16	41
(d) Work originating in graduate or undergraduate courses	14	35
(e) Administrative work	15	40
(f) Non-university work	4	9
(g) System development and testing	25	66
	100%	258

TABLE 2

MONTHLY COMPUTER USAGE

Month	Dalhousie University	Other Univ.	Gov't & Research	Commerce. Users	Total Hours	Total Runs
68 July	179.4	1.5	4.1	4.8	189.8	2838
August	161.3	0.0	5.5	3.5	170.3	2593
September	235.2	2.5	22.2	1.3	261.2	3312
October	179.9	5.3	8.9	1.6	195.2	3447
November	254.2	0.0	8.8	1.0	264.0	3911
December	217.6	0.8	4.3	0.5	223.2	2609
69 January	193.4	2.2	2.0	1.1	198.7	4717
February	221.4	0.9	4.0	0.2	226.1	5012
March	282.6	1.4	8.2	2.2	294.3	5944
April	214.3	1.2	12.4	0.6	228.5	4474
May	224.6	0.4	2.2	0.8	228.0	4764
June	241.0	6.5	3.1	0.2	250.8	5616
July	261.6	7.8	4.2	2.6	276.2	4509
August	268.9	4.0	0.6	0.7	274.2	4043
September	226.9	11.9	2.3	11.6	252.7	4577
October	227.3	1.9	2.2	10.5	241.9	5736
November	251.4	5.7	1.5	12.6	271.2	6245

2.2.2 Research

The percentage of time used for research has remained fairly constant at 40-50% at Dalhousie. It indicates that the heaviest use is research oriented. Among the more important users identified by the Director in his last report were:

1) The Physics Department with projects which include:
   a) Geomagnetic Field Research
   b) Annihilation Research
   c) Low Temperature Research
   d) Numerical solution of differential equations and random functions

2) Psychology and Sociology with projects which include:
   a) Alcoholism Research
   b) Attempts to explain mechanisms by statistical reduction of data collected upon observation of phenomena

3) Faculty of Medicine with projects which include:
   a) Study in the field of genetic research
   b) Cardiovascular research
   c) Patient record analysis

4) Other departments with work areas which include:

   a) seismic research

   b) fluid, trend and factor analysis

   c) crystallographic research

   d) nuclear magnetic spectroscopy, regression analysis

   e) library acquisitions, serials, and circulation programs

   f) registrar's student record compilations

   g) linear programming methods

It is important to remember that much of this research could not be done in Nova Scotia without the Dalhousie Computer Centre.

It is difficult to estimate or forecast research usage. It is dependent on too many factors that are difficult to assess. However, it should grow at least at the same rate as in the past. IBM suggests that at other major Canadian universities, research computing tends to double every three years.

Although it is impossible to give a detailed account of the composition of future use, five factors are at work which support the forecast of continued growth:

1) Many of the faculty most actively using the computer are new arrivals and have received their training elsewhere.

2) An increasing number of Dalhousie staff are recent graduates and have had exposure to computer technology.

3) As the Porter Report indicates, research workers now expect adequate computing facilities just as they do other utilities.

4) The greater availability of useful, developed "packaged" programs.

5) The improvement of the number, quality, and the type of teaching and training programmes that is being provided.

2.2.3 Education

It has been estimated that 75% of all undergraduate and graduate students, faculty and research workers could make use of the computer as a tool for their subject. Yet, at Dalhousie approximately 15% of the community have, as yet made direct use of the computer centre. Yet substantial progress is being made. (In his 1969 report to the UGC, the Director noted a figure of 10%).

From the beginning the goal of the Director was to increase usage by educating and training local users. It was a more difficult task, requiring more time than many would have wished and more effort than was anticipated. To establish a rational education program many other elements in the over-all development plan had to be resolved first. For example:

1) recruiting operators and systems programmers to operate the equipment;

2) recruiting programmers to provide some support for servicing outside users;

3) developing an administrative unit within a particularly difficult physical environment;

4) accomplishing any of the above without a clear cut statement of policy as to the specific role of the centre, both within and without the university;

5) recruiting trained personnel who could teach.

The most overpowering constraint was the lack of trained personnel on all levels. The salary levels and the work potential were too low to recruit quickly and effectively from Upper Canada. This was compounded by the fact that there was no pool of trained or available manpower in the Atlantic Provinces. This continues to remain true today, even though some inroads have been made towards solving the problem.

At present, education in computers at Dalhousie is by means of non-credit courses, while application of computer techniques to other disciplines is given through credit courses in the Departments of Mathematics and Engineering. There are only 138 students in the credit courses.

The non-credit program at Dalhousie is already substantial in both number of courses and variety. In addition, the initiation of a week long introductory program on the use of computers for freshmen, and development of a simple initiation of high school students on 4 consecutive Saturdays will reap many long range benefits. (Table 3 on the following page shows the range of this program).

However, problems remain that are worth underscoring:

1) lack of qualified instructors
2) the continued lack of awareness of the uses of computers by many students when compared to other Canadian universities.
3) the problem of faculty education

The continued lack of awareness on the part of students may occur because none of the courses are compulsory. At most universities offering engineering courses, all undergraduate engineers are required to take an introductory course in computer applications.* Similarly, in commerce or business administration programs, courses in linear programming and information systems are common and at least one computer course is mandatory. In fact, IBM reports that some universities in Ontario require all students enrolled at the university to take an introductory computer course.

The problem of training faculty in the use of computers is a far more difficult matter. No completely successful method has been found but a combination of the following approaches may prove the only way:

1) the greatest initial effort should be in disciplines which are already making use of the computer
2) younger faculty who have prior training or recognize the value of computers must be encouraged to help bring pressure on their colleagues to learn computer techniques
3) self-teaching programs should be initiated

* Actually Engineering 310 is not required by Dalhousie University, but is required for entrance to N. S. Technical College.

NON CREDIT COMPUTER COURSES, FALL TERM

The Computer Centre has planned extensive courses in programming languages for the academic year 1969-70. Each course will consist of two hour lectures per week over periods of six weeks. These courses will be non credit in the academic sense but if a student takes a course his transcript will indicate his taking the course and whether he passed or failed. All students must register at the Registrar's Office but students registered at Dalhousie will not be required to pay for the courses.

Following is the tentative schedule for the courses planned before Christmas. Classrooms will be assigned at a later date.

Tuesdays, Thursdays	12:30 p.m.	Introduction to Computing	Sept. 16 - Oct. 23
Tuesdays, Thursdays	11:30 a.m.	Basic Fortran	Sept. 16 - Oct. 23
		Interm. Fortran	Oct. 28 - Dec. 4
		Basic Fortran	Oct. 28 - Dec. 4
Mondays, Wednesdays	1:30 p.m.	Basic Fortran	Sept. 15 - Oct. 22
		Interm. Fortran	Oct. 27 - Dec. 3
Tuesdays, Thursdays	1:30 p.m.	Basic Fortran	Sept. 16 - Oct. 23
		Interm. Fortran	Oct. 28 - Dec. 4
Mondays, Wednesdays	1:30 p.m.	Basic Fortran	Oct. 27 - Dec. 3
Mondays, Wednesdays	2:30 p.m.	Basic Fortran	Sept. 15 - Oct. 22
		Interm. Fortran	Oct. 27 - Dec. 3
Mondays, Wednesdays	3:30 p.m. Non-Scientific	Basic PL/1	Sept. 15 - Oct. 22
		Interm. PL/1	Oct. 27 - Dec. 3
Tuesdays, Thursdays	1:30 p.m. Scientific	Basic PL/1	Sept. 16 - Oct. 23
		Interm. PL/1	Oct. 28 - Dec. 4
Tuesdays, Fridays	4:30 p.m.	Basic Cobol	Sept. 16 - Oct. 24
		Interm. Cobol	Oct. 28 - Dec. 5
Wednesdays, Fridays	11:30 a.m.	Basic Cobol	Sept. 17 - Oct. 24
		Interm. Cobol	Oct. 29 - Dec. 5

TABLE 3

NON-CREDIT COURSES
CCURSES AT DALHOUSIE

N. B. As well as these, additional courses were given to freshmen, high school students and on on Job Control Language and Assembler.

4) administrations must provide opportunities, at no monetary cost to faculty members involved, both on and off campus for suitable instruction.

To begin action and insure continued progress several steps have been taken:

1) Consideration is being given by the Dean of Arts and Science establishing as a graduation requirement, one mandatory computer course.

2) Since the shortage of trained personnel to teach, service, staff, and operate computer programs and installations is acute throughout the world, and most particularly in Nova Scotia, a Computer Science Department is essential. One place for such a department might be the Nova Scotia Technical College. Discussions between appropriate Deans are now underway with financial limitations the only apparent problem.

3) the experiments with high school students in the use of computer applications are being extended and expanded.

4) the introductory course to freshmen will be a permanent feature of the centre's program and attempts will be made to repeat it during the year for those who missed or skipped it at the time of the original offering.

2.2.4 Personnel

It should be self-evident that assessing staff needs is impossible without a fairly specific analysis of the services to be performed. A look at Tables 4 and 5 which follow will give an idea of what the former Director believed a reasonable staff projection, that is if one did not include an administrative services group, a Computer Science Department, or a regional services group. Moreover, it reflects a modest package in support of the university's research and educational needs. In addition, if one compares the salaries to those paid by other universities (see Appendix D), one will note that some financial upgrading is in order and this has some effect on the projected budget.

It is a rule of thumb in the computer world that 2 to 3 times more money must be spent on software* rather than on hardware* if maximum value is to be derived from a centre's operation. If this is true, the centre is underestimating its staff requirements by at least 1/3 and its total budget by at least 1/2 - even without the addition of the service units which are not considered in the original estimates and would involve still greater cash outlays.

In the case of the administrative service unit and the regional service, two kinds of personnel who are not presently available will have to be recruited: Systems analysts and system designers. Advice as to where and how to proceed in these areas will be needed by all users. Other supporting staff will be needed, but co-operative planning could offset most of the cost. In its initial stages of development a minimum of three systems analysts and one systems designer would be needed. More would be added as this type of service were required. In any event, at salaries ranging between $12 - 15,000 even this modest effort would require a yearly expenditure of $50,000.

* The term 'hardware' refers to tangible electronic and mechanical apparatus installed at the Computer Centre. The term 'software' refers to intangibles such as the education, programs and procedures intimately associated with the hardware.

TABLE 4: PROJECTIONS FOR COMPUTER STAFFING LEVELS

	1968-69	1969-70	1970-71	1971-72
Administration				
Director	1	1	1	1
Asst. Director	0	0	1	1
Secretaries	3	3	4	4
Computing Services				
Professional	1	1	1	1
Operators	9	11	12	14
Clerical	1	2	3	4
Systems Programming				
Professional	2	4	6	8
Programming Services				
Professional	6	6	7	7

TABLE 5: PROJECTIONS FOR GROSS COMPUTER CENTRE BUDGET LEVELS

	1968-69	1969-70	1970-71	1971-72
Equipment	220,000	335,000	388,000	440,000
	(52%	53%	47%	48%
Staff	150,000	228,000	332,000	406,000
	36%	36%	41%	42%
Support	50,000	68,000	90,000	100,000
	12%	11%	12%	10%
Total	420,000	631,000	810,000	946,000

N. B. Thes tables are quoted from the Director's Report to the UGC, April, 1969, and anticipate the development described in Appendix C.

Strengthening the teaching and training staff remains the princip priority. For reasons already noted, this is the best long-range solution to the problem faced by the university. Many potential computer applications can not be made because of lack of trained people. This matter assumes some further urgency at this time in view of IBM's announcement that it is withdrawing its free computer education courses in February 1970. In addition to charging for education on a fee basis, it will shift its concentration to advanced education courses. Since IBM is the major supplier of computer education in Nova Scotia, this new policy could mean that we will fall further behind in computer development.

2.2.5 Equipment

Table 5 projects the gross computer centre budget levels, including those for equipment. Tables 6 and 7 on the following pages indicate the anticipated schedule for augmenting the system. These tables are no longer valid but are of interest because they show the anticipated monthly and yearly rental levels. The equipment is no longer needed for four reasons:

1) delays in the completion of the new Computer Centre
2) lack of interest and use in the existing centre by outside users
3) lack of assurance of financial support from the Provincial Government
4) announcement of withdrawl of support by NRC

The costs of a major computing centre are so great that Dalhousie could not undertake the expense on its own.

In planning the enlargement of existing facilities, Dalhousie was guided by three principle considerations :

1) range of service to be provided
2) quality of each service
3) the financial limitations

Behind each of these considerations was the understanding that the centre was to become a regional centre.

One of the requirements of the regional system was the provision for remote terminals. These would insure accessibility and adequate 'turn around' time. Estimates for the 1970-1971 and 1971-1972 budgets were based on the expectation of substantially increased activity following the move to the Killam Library, substantially increased payment for computer hardware from IBM (extending from a present level of $17,551 per month to reach $33,445 per month by January, 1971 - see Tables 6, 7). Adequate regional service, using IBM 360 equipment, at an annual cost of less than $345,167 is very unlikely. The additional equipment which was to have been added in July 1970 was for flexibility rather than additional computing power. Later additions of more high speed core and a second selector channel would be needed to handle an increased total work load.

Equipment rentals were to be reduced by approximately 3% from February. However, many additional services now provided free will be charged for, including program rentals. As yet, IBM has not responded to a request for a detailed list of equipment price changes; so that, an accurate assessment of any savings cannot be made.

If the budget for 1970-1971 is set at $576,216 (2/3 of the requested level), it would allow for continuing the operation at its present level with an incremental amount of $60,635. This would allow for modest salary increases, a few additional staff, and some additional equipment. It would in no way increase the level or the quality of service now available, although some improvement can be expected as existing staff gain experience and the operation is tightened. By extending the above argument to the 1971-1972 budget, another modest increase ($75,000)would allow us to continue the existing level of operation with minor improvements.

TABLE 6

Configuration of Costs of IBM/360 Equipment at Dalhousie University

Present Configuration (September 1969)

/360 computer model 50		
128 K bytes	$16,016.66	per month
(4) 2311 disc drives		
(3) 2401 tape units		
1403-N1 printer	($192,199.82	per year)
2540 card reader/punch		
2821, 2841 } control units		

July 1970 Configuration (as anticipated, September 1969)

delete:		
(4) 2311 disc drives		
2841 control unit		
add:	add:	
2314-A1 disc file	$11,212.74	per month
2401 tape unit		
2701, 2702 } communications adapters	($134,552.88	per year)
(15) 2741 typewriter terminals		
2361 large core storage		

January 1971 Configuration (as anticipated, September 1969)

add:	add:	
128 K core (to 256K)	$4,681.66	per month
Second Selector Channel		
(9) 2741 typewriter terminals	($56,179.92	per year)

Given the existing financial climate and the continuing deficit Dalhousie has incurred in the operation of the computer centre, it became necessary to cancel equipment now on order, including the IBM 360/65 ordered by D. E. Coates.

If new sources of revenue were discovered, and if regionalism, with all its financial implications, were to be considered seriously by interested universities, the whole matter could be opened again for discussion.

2.2.6 Information Services

To maintain and establish interests, to increase the level of awareness, and to insure the necessary publicity for existing programs it is important that the centre dispense pertinent information to all potential users. During the past year such communication has been accomplished by means of:

1) non-credit courses
2) seminars, colloquia, and other presentations
3) announcements in the Dalhousie Newsletter, the Dalhousie Gazette, and other newspapers
4) publication and distribution of:
    a) Quick Computer News (an attempt to inform users quickly about sudden changes in operation procedures or sudden policy changes)
    b) University Computer Centre Newsletter (the prime information medium regarding the activities of the computer centre)
    c) Programmer's Reference Manual (updating of technical literature)
    d) Monthly Report (a monthly analysis by the Director)

Many of these elements are new or represent a substantial improvement and expansion over former services.

One immediate change is being implemented: the Monthly Report is being discontinued. Information from the Monthly Report will be incorporated in the University Computer Centre Newsletter. Sudden changes in policy or operation will be treated as special news or by way of a widely circulated memorandum. It is hoped that this will improve the quality of the remaining publications and that some staff time will be freed for other purposes.

2.3 The Need For Excellence

"After growing wildly for years, the field of computing now appears to be approaching its infancy ... Computing is a new resource in learning. It enables the student or the scholar to deal with realistic problems rather than over-simplified models. By lessening the time spent in the drudgery of problem solving and in the analysis of data, it frees time for thought and insight. Partly, it enables the student to do old things more easily, but more important, it enables him to do things he otherwise could not. Computing increases the quality and scope of education..... They have made masses of data, which were previously completely intractable, accessible to analysis and understanding. [Computers] have made it possible to trace the consequence of theories and assumptions..... Indeed, it seems that the social and economic gains which can be made through the use of computers and computing may be limited chiefly by the availability of people who are able to apply these tools in new and useful ways."[1]

"The computer now plays such a fundamental role in so many research projects that even those who rely heavily upon it take for granted that adequate computer facilities, staffed by qualified personnel, will always be available without special additional costs to their research projects.... Because of this attitude, and because Canada's future computer requirements have not been systematically assessed, there is a grave danger that inadequate provision for computers will be made in the allocation of funds for research and teaching. This could be disastrous, for the computer represents a technological breakthrough that affects the rate of technological advance itself. If inadequate resources are available to finance the expansion of computer facilities, this will have serious repercussions, not only on computer technology in Canada, but on the rate of discovery in many other fields. Not only will those conducting research within universities be seriously handicapped, the universities will be unable to provide a rapidly expanding cadre of first-class systems analysts and computer programmers needed in the full utilization of modern computer systems outside the universities..."[2]

"The economic and cultural strength of a nation largely depends on its ability to take advantage of new developments in science and technology.... Despite its comparative infancy, the computer is already influencing more scientific and scholarly disciplines than any other research instrument or technique developed in recent times."[3]

[1] Computers in Higher Education: Report of the President's Science Advisory Committee, Washington, 1967.

[2] Porter, A., Hartle, D.G., and Hill, T.E., Computer Facilities in Canadian Universities, 1967.

[3] Computer Facilities in Canadian Universities

In the preceeding pages we have argued that computing facilities are as necessary to the operation of a university as heat, light, and water. We have further argued that the available computer resources have an effect upon the surrounding geographic area: good services can provide the basis for rapid social and economic growth, inferior services mitigate against such growth. There can be no question that the future material and intellectual life of the region will lag further behind other parts of Canada without adequate provision for powerful computing services. Nevertheless, financial constraints are real and the costs for such service enormous. How, then, is one to appraise the validity of the costs implied in this report.

Both the Pierce and the Porter reports quoted above were written for federal governments. Each is emphatic about the lack of properly supported and adequately planned computer developments. Each notes the stupendous costs involved but offers no alternative to governments but to find money. More specifically, each is concerned with the fact that "we have a second class education for the majority".[1] Five reasons are cited:

1) lack of an appreciation of the usefulness of computing on the part of faculty

2) lack of suitable instruction

3) lack of suitable languages

4) lack of adequate computer facilities

5) lack of adequate financing or appropriate administration.

It is clear that in Canada, and more particularly in Nova Scotia, a country and a province with limited resources for research, painful choices must be made between alternatives.

2.3.1. Assessing Cost Estimates

The obvious way to compute the cost to the university for operating the centre is simple:

1) cost of equipment (all equipment)

[1] Computers in Higher Education

2) cost of personnel (all personnel)

3) cost of supplies and miscellaneous expenses (travel, recruitment, training, etc.)

4) cost of all overhead and indirect charges (heat, electricity, lighting, space, etc.)

But knowing this figure is only moderately useful. It is only an indication of the amount spent in relation to the total university budget. It does not tell you how or why or whether the money is being spent usefully.

In order to establish some theoretical guidelines on how much should be spent on computer hardware, Table 8 is included. It presents actual monthly hardware costs per month per student for Canadian universities. The costs tabulated include Dalhousie twice: on the basis of the equipment which was formerly on order, and on the basis of existing equipment. No comment is necessary as the Table speaks for itself.

In a computer survey initiated by D.E. Coates which included all A.P.I.C.S. members, the following information relating to St. F. Xavier, Acadia, Dalhousie, BioPhysics-Dal was derived. (St. Mary's and NSTC are not included because they did not complete the questionnaire.) Information regarding overhead and indirect costs was omitted.

With the exception of Dalhousie, no other Nova Scotian University is approaching the expenditures noted for other Canadian universities. What makes the situation still worse is the fact that the figures in Table 9 include software costs!

The Pierce Report[1] estimates that at the present time adequate computing costs $60 per student per year averaged over all college students in the U.S. When compared to the $150 to $200 per student per year for college libraries and an estimated $95 per chemistry student per year for a single chemistry laboratory course, the cost seems modest. It is further estimated that the $60 cost per student per year represents around 4% of the overall educational cost.

In the Porter Report[2] it is estimated that each university should be spending a minimum of $36 per undergraduate and $260 per graduate student by 1969-70. This figure rises sharply so that by 1974-75 the cash outlay is $67 per undergraduate and $1400 per graduate student. The Porter Report is even more modest in its projection of Canadian University computer costs as a % of total university operating budget. In 1969-70 it recommends an

[1] Computers in Higher Education

TABLE 8

COMPARATIVE COSTS FOR COMPUTER HARDWARE

	Student Enrollment			Cost per Student Per Month for Hardware	
	Range (000)	Median (000)	Mean (000)	Median	Mean
17 Canadian Universities	2-23	7	9	$7.80	$7.60
6 Canadian Universities	4-7	5.7	5.7	$7.90	$6.90
Dalhousie (Including Planned Equipment)		5.6		$5.10	
Dalhousie (Installed Equipment Only)				$3.06	

TABLE 9

Selected Information from A.P.I.C.S. Computer Survey

Total costs for 1968-1969

Item	Total for N. S. Universities
A. Employee salaries and benefits	$223,968
B. Payments to Vendors	$381,184
Totals for year	$605,152

Evaluation

This is a breakdown of the total costs by university showing the percentage of cost for each of A. and B.

University	Total for N. S. Universities	
	A.	B.
Acadia	12%	7%
St. Francis Xavier	5%	7%
Biophysics - Dal.	16%	15%
Dalhousie	67%	71%

Breakdown of Costs in 1968-1969 by FTE Enrollment

University	Machine	FTE Students *	Total Expenses	Cost/Student
Acadia	1130	2066	$ 52,000	$25.17
St. F. Xavier	1620	2701	$ 38,503	$14.26
Dalhousie	/360 50	7547	$460,200	$55.78

* "FTE" denotes Full Time Equivalent

expenditure of 2.2% rise to 3.9% by 1974-75. So that these figures will not be misinterpreted one most important point must be made:

THE FIGURES RECOMMENDED BY BOTH REPORTS DO NOT INCLUDE MONIES SPENT FOR ADMINISTRATIVE OR COMMERCIAL APPLICATIONS. FURTHER, THEY DO NOT INCLUDE EXPENSES INCURRED FOR A COMPUTER SCIENCE DEPARTMENT.

On the basis of the above criteria, Dalhousie is doing well. It is spending 4% ($656,000/$16,500,000) of its operating budget. Even if one adjusts the figure to 3% (1% of the existing use is for administrative and external use) it is slightly above the requirements of the Porter Report and meets the standard developed by the Pierce Report. Clearly, then, if regionalism is not embraced Dalhousie, by changing its hours of operation and restructuring its program, could remain at its present budget level, as modified earlier, for the next 24 months without hardship to its local community of users, and the area would still have a powerful computer for use by all.

This may not be possible unless the decision is based on two factors:

1) the UGC continues to partially subsidize the operation
2) a way is found to replace the NRC grant.

The alternatives are self-evident:

1) Downgrade the Dalhousie University Computer Centre thus reducing the research committment and potential of both the university and the area. It would also insure the dearth of qualified computer personnel in Nova Scotia forever.
2) Find other sources of revenue
3) Review the whole question of regional computer development. According to the standards posed by Pierce and Porter, NO UNIVERSITY OTHER THAN DALHOUSIE IS SPENDING ANYTHING NEAR THE AMOUNTS RECOMMENDED FOR ADEQUATE COMPUTER EDUCATION.

The final course seems to be the only sensible possibility. Since money is and will remain scarce for the predictable future, and since no one in Nova Scotia has found a way to provide adequate training and education without the necessary facilities and funds, no other solution can be seen. (As the UGC knows, this is the position which was adopted by Nova Scotian Universities at a recent, special meeting called at their urging.)

2.3.2 Financing the Dalhousie University Centre

In pleading for special support form the UGC, it should be made clear that Dalhousie is not asking for favoured treatment. In terms of its overall budget it has devoted a larger portion of its operating budget to computing than other Nova Scotian universities. According to Table 9, Dalhousie is spending more than half of all monies reported on salaries for employees working in computer centres in Nova Scotian universities, and it is spending more than three quarters of all monies reported for equipment costs. For example, for the Dalhousie Computer Centre (but not including the Biophysics computer):

In 1968-69 its expenditures were	$459,000
In 1969-70 are expected to be	$650,000

In 1968-69 it received $94,900 from NRC grants and $100,000 from the Provincial government. This means it had to allocate $300,000 from other resources. In 1969-70 it has received no special grant from the Provincial govt. and $70,000 from NRC. Since Dalhousie is expecting $200,000 from the Provincial government and is operating on a balanced budget, the loss of this money would force a downgrading on the centre and its activities. What is needed is another approach to financing computing in Nova Scotian Universities.

Unlike Dalhousie's library which inherited the de facto role of a regional referral centre without the benefit of official sanction or added financial resources, the Computer Centre can and should develop differently. No university should be burdened by the considerable burden of unfair or extraordinary costs. Since the equipment available is flexible and since the state of the art in Nova Scotia is in its infancy, its campus location is not important but financing is.

There are many possibilities for deriving more realistic approaches for financing computation in Nova Scotia. For example:

1) direct grants to each institution for computer service to students based on how and where computer services were to be provided

2) a special, separate unit grant per user based on whether he is an undergraduate or a graduate researcher, or faculty member

3) the establishment of a Crown Corporation which would develop a regional centre for use by universities and secondary education institutions. (In such an arrangement a fee may not have to be charged to the users)

4) direct grants to a regional centre (e.g. Dalhousie) for services they are expected to perform for other participating members. The grant would be paid whether the participating member used his appropriated time or not.

5) the shifting of responsibility for a regional Computer Centre to the Department of Education.

Any of these would solve Dalhousie's financial problem and would probably be acceptable. It would also be possible, if the centre were to be administered by another party, to negotiate for the use of the Computer Centre planned for the Killam Memorial Library. All avenues should be explored, including a review of the utility and costs of the present equipment configuration.

2.3.3 Future Development

Regardless of regional computing developments, it is obvious that the Computer Centre must continue to improve the quality and quantity of the services provided. Emphasis will be on three goals:

1) extend its range of user education services to improve the education experience of students and to increase the pool of available manpower

2) become more involved in university administration

3) lobby as actively as possible for a well operated, soundly financed regional computing centre in Nova Scotia.

How much more simple this would be if one could control the quality and quantity of students, or if one could accurately assess the administrative and research needs, or if one could predict with some degree of certainty the financial requirements, and personnel resources which would finally be available. Moreover, beyond all these variables looms another area that has not been discussed but is worthy of investigation - Computer-Assisted Instruction. The mind boggles when it considers the potential - both in the staggering costs and in the educational possibilities.

3

THE COMPUTER CENTRE AND REGIONAL PLANNING

The advantages of a regional computing centre which provides its users access to the most powerful machine which can be jointly afforded are well established. Regional computing is undoubtedly the most effective and efficient use of computing resources (Appendix B gives two operating examples) and the intention of APICS to set up the nucleus for such a centre at Dalhousie University in 1968 follows the best established practice. A look at the typical figures provided earlier (Table 2) clearly indicates that the regional aspects of the centre's use are negligible. Regional use of the centre is not taking place. This suggests a flaw in the original concept of regionalism, a possible lack of need, a problem of execution, or some combination of these elements.

3.1 Policy vs. Practice

A review of the history of the Dalhousie Computer Centre might help. The chronology of events which follows shows that a computer powerful enough to allow initial regional experimentation was available from 22 January 1968; that the Centre was founded with the explicit purpose of developing a regional centre; and that the UGC provided a modest initial grant towards getting the project off the ground. Yet, non-Dalhousie University usage has not increased from its original, negligible amount for the first 19 months of operation. One can find many elements to blame (e.g. lack of direction, mismanagement) but this would only hide the true problem: THE NEEDS OF THE PROVINCE WERE NOT FULLY MATURE AND THE USERS NOT SUFFICIENTLY TRAINED AT THE TIME THE MONEY WAS SPENT.

Chronology of Dalhousie Computer Centre Operations

December, 1962:	IBM 1620 installed in Sir James Dunn Building
Summer 1963:	1620 upgraded and moved to Arts and Administration Building
1 April 1965:	Dalhousie faculty meeting resolved to investigate feasability of computer centre establishment

17 August, 1965:	APICS Computer Sub-Committee sets up working committee to examine centralized computer system installation "to provide adequate computer facilities for education, research, and the overall development of the Atlantic Region".
19 October, 1965:	President Hicks institutes President's Advisory Committee on Computer Science.
19 November, 1965:	President's Advisory Committee recommends education program in computer science, increase in computer centre staff, and appointment of a full-time centre director.
22 February, 1966:	APICS working committee recommends steps towards Halifax area centralized computer facility.
1 July, 1966:	Professor H. S. Heaps takes up appointment as Director of Computer Centre.
September, 1966:	1620 moved to 6171 South Street (Computer Centre Annex)
17 November, 1966:	President's Advisory Committee, after reviewing APICS working committee's hardware recommendations, adopts the following motion: " The University will need by 1970 the services of an IBM S/360 67 computer. To meet its needs for the next three years, the Committee recommended acquisition of a S/360 Model 50 as an intermediate step. The Committee also recommends the University talk immediately with the Provincial Government and other interested institutions about the co-operative provision of System/360 Model 67".
January, 1967:	IBM 1800 installed in public health clinic building.
Fall, 1967:	1800 moved to Biophysics laboratory, replaced 1969 by SDS Sigma 7 (not under centre control)

September, 1967:	Dr. J. Lions became director of Computer Centre
December, 1967:	S/360 Model 50 installed in Basement of Old Law Building
22 January, 1968:	S/360 M 50 becomes operational
30 April, 1968:	1620 returned to IBM

3.2 Advantages of Regional Services *

The main advantage of a regional computing centre are a direct result of the concentration of very large computing facilities in one place:

a) The economies of scale are very high. Larger computing facilities provide computing power at lower unit cost per computation. (in North Carolina, one university estimated it was able to obtain four times as much computing power for the same number of dollars spent).

b) Users have access to elaborate facilities. Highly sophisticated computer service, the ultimate in computing speed and capacity, and a highly competent technical and administrative staff are resources concentrated in a regional computing centre which are available to all its users. No one user would be able to afford such powerful resources on its own.

c) Costs are spread over several users. Although each user has advanced facilities at his disposal, he pays only part of the total cost.

d) New users can be added easily. Once the staff are trained and its facilities operational, a regional computing centre can add new users quickly and make available to them up-to-date computing service. The alternative is for new computing users to slowly develop their own experiences and facilities.

e) A common front of users is established. Several users can negotiate more easily than a single user, with the suppliers of computing communications service and computing hardware.

f) Co-operation among users is enhanced. University departments using regional computing centres have found that many more useful meetings and discussions have taken place among faculties of the universities concerned.

* See Ontario Committee on University Affairs, Computer Study.

3.2.1 Requirements for a Stable Regional Computing Centre

The implementation and design problems associated with the development of a regional computing centre are large, and the requirements for a stable regional computing centre are different from those one would expect to find at a local university computing centre.

The following requirements seem necessary to ensure the success of a regional computing centre:

a) a regional computing centre is a service-oriented organization. The centre must endeavour to provide the very best service in order to enhance the teaching and research programs of all users and to continue to attract them to the regional centre.

b) a regional computing centre should be set up on a stable financial basis. The financial arrangements must prevent spiralling of computing costs resulting from temporarily decreasing loads from one user. Long term plans must be made, and will require financial stability to be realistic.

c) a regional computing centre requires a well-managed and competent staff. In order to provide a high level of service the centre will need capable management and technical staff who are able to implement and provide sophisticated computer services.

d) a regional centre must be able to absorb increases in work load. Existing users will increase their workload because of the more useful facilities. New users having difficulty establishing their own facilities will be attracted to a regional centre, and must be absorbed without affecting utilization by other users.

e) a regional centre must provide a diversity of sophisticated computing services. One advantage of a centre is its ability to provide a wide variety of computing machinery, and larger, faster, computing machines, than any one user could afford.

f) accounting and scheduling procedures must be automated. These procedures must be formalized and then implemented by the computer itself in order that they be administered with absolute objectivity. In addition, the very high volume of work at a regional centre does not permit time to carry out these procedures manually. To avoid conflict, scheduling and accounting should be done on the basis of:

- estimated run time
- assigned priority
- differential use to date between users
- computing facilities required by a job
- length of time job has waited for service
- most effective machine facilities

3.2.2 Organizational and Financial Requirements

The ascending scale of complexity from university service to a Provincial regional service necessitates clearly enunciated organizational requirements and policies. Two principal problems must be solved:

1) funding of the centre and charging procedures
2) organization of centre with distribution of authority

Many questions must be answered. For example:

What constitutes an actual charge?

Should there be user contracts for availability of use?

Will there be a rebate for time paid for but not used?

Shall distance be a penalty in terms of costs?

The organizational requirements that are generally associated with operating a Regional Computing Centre include:

Board - policy, major decisions; should be senior member of academic and administrative staff

Director - Manager with academic empathy

Users Advisory Committee - Directors of other computer centre and senior users

There should also be a systems group, a development and planning group, an accounting group, an operations group.

Since university funding is a provincial responsibility, provincial government funding policies should be changed to insure regional computing centre growth.

3.2.3. Services and Facilities offered by a Regional Computing Centre

Finally, the primary requirements of a regional computing centre are that it be a service oriented organization which is well managed, and provides a wide range of computing services to its users. Some of the components of such a service would be:

a) Advisory service. Users require systems advice on 'how to use' the regional centre services, documentation of all programs, information as to type of services offered, changes in schedule, and new developments. New users require initial assistance in shifting their computer work to the regional centre.

b) Software. In implementing major software packages suggested, the centre must select those which are supported consistently by a qualified group or organization, which are fully tested, and which do not change frequently because of errors or changes in design.

c) Hardware. Computing equipment must be expandable in such a way that expansion does not inconvenience existing users. The regional computer must have adequate capacity to guarantee a fast turn-around service, and be able to handle alterations in user numbers.

d) Automated Operating Procedures. These will balance the computer load so that the computer is effectively utilized, and service thereby improved. A regional computing centre would implement a 'timesharing' or 'partitioning' system which would allow several types of programs to operate within the computer in one time.

e) Operating Policy. The tendency will be for users to maintain files of information at the regional centre. Policies will be required for storing and protecting such files, and where necessary, preserving the security of the information on them.

3.3 Restrictions on Regional Centre Development within Nova Scotian Universities

1) The Dalhousie University Centre does not have a clear mandate within which to plan its development.

2) The Dalhousie University Centre is not funded as a regional centre. As a result it was unable to provide the kind of service to other institutions which appears to have been needed when it was started. It is already a heavy drain on Dalhousie's resources, and cannot be supported without additional financial aid.

3) There was a general lack of direction, a lack of formal planning, no policy making board and no financial arrangements to which participants had agreed.

4) There was a lack of initiative on part of other educational users.

These restrictions have, along with the internal problems of the centre already discussed, hampered effective growth. Item 3 above, however, reflects directly on the willingness of other educational institutions in the province to establish and contribute towards an effective regional centre. Naturally, the tendency is for each institution to desire its own independent centre, under its own control. Such desires in the Nova Scotian situation, where there are neither the financial nor personnel resources to support more than one large computer centre, must be curtailed. Promotional activity towards other educational users in the province should not be necessary to make or prove this point.

Still another restriction in establishing regional service has been "turn around time". Regional activity can take place now with no additions in the form of equipment, if participants so desired. The centre has the unused time, and a delivery van service with maximum 24 hour turn-around service to remote users and 12 hours turn-around service to nearby users could be established easily. These turn-around times are not excessive in view of the fact that the sort of work most suited to the regional use concept is research activity beyond local resources. Moreover, it is better than the time available to many users on their own campuses (U. of T., Brown, etc.). Nevertheless, even this modest form of regional activity "on the cheap", though suggested, elicited little or no interest on the part of users. As a result, it was neither extensively investigated nor in any way implemented.

4

CONCLUSIONS AND RECOMMENDATIONS

With the exception of Dalhousie University's Computer Centre, Nova Scotia is computer poor. If nothing is done to improve the situation, the economic, social, and educational growth of the province will suffer.

Students will suffer because they may be denied access to a suitable computer. This will affect the quality of their education and, if they are not taught appropriate computer skills, will affect their future job potential.

Researchers will suffer because sufficient computer power for solving research problems may be unavailable. Some will leave the area; recruiting others may become impossible.

Administrators will suffer because they will be unable to utilize the computer to develop suitable accounting, record keeping and budget forecast techniques. Moreover, computer simulation techniques which allow a more accurate assessment of needs and costs will not be possible.

Business, Industry, and Government would suffer because research would be minimized, education would deteriorate, and skilled computer personnel, on all levels, would be unavailable within the area. Recruitment is already a serious problem.

For these reasons and all others presented in the body of the report, we recommend:

1) Establishment of a Computer Science Department. It should be located in the Halifax/Dartmouth area and should serve the needs of all universities. It might best be located at NSTC. (Negotiations are underway between Dalhousie and NSTC. Some financial support will be required).

2) Establishment of a Regional Computer Centre along the lines described in the report. It should be located in the Halifax/Dartmouth area. It should serve the needs of all universities and research institutions. (It need not be housed at Dalhousie).

3) Establishment of a new method for financing computing within universities. Computing is expensive; no university can afford to develop programs on the basis of existing financial grants. (Several possible and interesting suggestions have been made in the body of the report).

4) Establishment of a special grant for Dalhousie University's Computer Centre. This would insure continuity in computing while the UGC, in association with all other Nova Scotian universities, resolves the problems posed in the first three recommendations. Dalhousie should not be forced to downgrade its facilities while discussions and negotiations are occurring.

APPENDICES

APPENDIX A: A METROPOLITAN SERVICE PROPOSAL

Computer Service in the Metropolitan Area

1. The Need for Metropolitan Service

The Maritimes are traditionally removed from Canada's resource and production areas in Central Canada. The same holds true for Computer Resources. There is a great wealth of computer resources in the Ottawa-Toronto-Montreal area, but the high cost of data transmission to this resource area inhibits the Maritime Provinces from accessing these resources. One solution would be providing every activity in the Maritimes which needs computational services with a computer. The economic paucity in the region would force each separate centre towards small, inexpensive machines, but: "if we accept the premise that all computing gravitates to the largest possible machine, small machine proliferation becomes untenable."[1] Regional service is the only solution to the computer resource provision problem; the first steps toward this regional service must be taken in the local Halifax-Dartmouth metropolitan area, to build up the service techniques and programs. There is a wide area of possible applications, from service to surrounding institutions, to secondary school service, to regional industrial research and production services.

The power of the computing resources available is the paramount parameter of regional service. Logically, service extension should proceed with Dalhousie's computer in the present input mode until the workload becomes too heavy. Then we must choose between extended centre operations (with little machinery cost, but a greater outlay for personnel and power to operate for the longer periods) or improved input modes for the computer. In a year or two, the workload should be so great that no extension in working hours will be possible, and then input mode alteration will be unavoidable, if the centre is to continue to offer proper service.

[1] PSAC Report on Computers in Higher Education, p. 43

APPENDIX A: CONTINUED

2. Opportunities and Arrangements

The opportunities for service is shown by the table which follows of non-Dalhousie users, illustrating a wide range of data-processing applications. Thus, a general-purpose computer, as Dalhousie has at present, is necessary for such service.

The most productive alteration to the input mode of the computer is "time-sharing", a process which allows the central processor of the computer to work without interruption by servicing needs. Two or more programs are loaded in the computer simultaneously, and as the computer halts for one program (usually one with a high priority code, since it will have a large number of external servicing halts), it can operate on the other until the first program is serviced. Remote terminals, such as teletypewriters, are usually associated with time-sharing, but they need not be. A computer can run in a time sharing mode as long as there are two sources of program input, such as two card readers. Terminals are very valuable devices (see Appendix G), but they require a software operation which does not mean great additional systems costs.

Program and data delivery to the metropolitan service centre need not be by electronic means unless immediate turnaround is needed; such needs will not be present in the near future for Dalhousie's service region. Program and data delivery can be made by mail, or by local delivery vans (The Triangle Universities' Computer Centre services its clients effectively in this manner for over a year). Metropolitan Regional service can be implemented easily without great cost increases, and without straining any present resources.

NON-DALHOUSIE USERS WITH ACCOUNT NUMBERS AT THE COMPUTING CENTER

Acadia University
Atlantic Data Systems
Canadian Agricultural Research Station, Kentville
APICS
Bedford Institute of Oceanography

Fairey Aviation Ltd.
Fowler, Bauld, & Mitchell
Federal Dept. Fisheries, Halifax
Hawker Siddley Canada, Ltd.
Halifax West High School

Maritime Life Association
Nova Scotia Department of Mines
Maritime School of Social Work
Mount Saint Vincent College
Maritime Tel & Tel

Pratley & Dorton Consulting Engineers
Robert L. Comeau
Stephens Construction Ltd.
St. Francis Xavier University

Board of School Commissioners
Desourdy Construction Ltd.
Dacon Engineering Ltd.
EMI Cossor
Computer Services Bureau, Ottawa

Imperial Oil Fior Research Plant
James W. Cowie
McDonald Construction Ltd.
Memorial University
Federal Dept. Mines, Halifax

National Research Council, Halifax
Nova Scotia Light & Power Co.
Nova Scotia Research Foundation
Nova Scotia Technical College
Omega Construction Ltd.

St. Mary's University
Stevenson & Kellog
Dept. Trade & Industry, Halifax
V. C. Woodworth Ltd.

APPENDIX B: REGIONAL COMPUTING CENTRES

TRIANGLE UNIVERSITIES COMPUTER NETWORK (Duke University, North Carolina State and the University of North Carolina)

1) A separate computer facility financed by equal payment from the three universities and from external usage.
2) A board of directors made up of three from each university, one finance man and two department heads, makes all the decisions on policy and also the hiring of the president of TUCC. (TUCC is a separate wholly owned corporation).
3) Monthly meetings of the individual computer centre directors together with the president of TUCC, who is the chairman. The directors are ex-officio members of the board of directors without a vote.
4) The queueing algorithm involves the length of job, the amount of use today and over longer terms, and the priority of the job.
5) Type of equipment: two 360/40's, one 1130, many teletypes 2780's, 2741's, and 1050's, attached to a central S/360 Model 75.

PROVINCE OF ONTARIO

1) The management board -- one representative per university, non-computing personnel but man to whom director of computing centre reports.
2) Technical committee, an advisory board, composed of the computing centre directors.
3) Financed by grant of $x (2 then 6) for each basic instruction unit to the computing centre group.
4) The computing centre group is a full time bunch hired from outside the university community to achieve the objectives directed by the management board which involves economies of scale and the implementation of inter-university operation.

Reports on this organization can be obtained from Dr. Douglas Wright, Chairman of the Committee on University Affairs, 481 University Avenue, Toronto, Ontario.

APPENDIX C: ONE PROPOSAL TO AUGMENT THE DALHOUSIE COMPUTER CENTRE

During the latter part of 1968, plans were laid to augment the 360 Model 50 computer at Dalhousie University, following the move to the Killam Library, and appropriate equipment orders were placed at that time, in order to obtain delivery positions. As explained in the report, these orders were cancelled in November 1969.

In June, 1969, the Centre announced details of the proposed expansion to the community at large. The following appendix is an abridged version of a document published by the Dalhousie Computer Centre in June, 1969.

C.1. Introduction

An expansion of equipment and facilities to the IBM/360 Model 50 computer that will greatly affect the research, administration and educational functions of the university has been scheduled to occur immediately subsequent to the move of the computer centre to the basement of the new Killam Library.

It is expected that present facilities will be disassembled and moved commencing January 5, 1970, and will be back in operation no later than January 16, 1970. Late in January additional equipment consisting of 1,000,000 bytes of low speed core (a LCS unit) and a new larger disk storage unit will be added. The computer will have then the capability of driving several typewriter-like terminals (2741's). By mid-February it is hoped that these terminals will be fully operational within Dalhousie University.

In March a further stage is planned when arrangements have been made to accommodate IBM 1130 computers as terminals connected to the IBM/360 computer via telephone lines. Nova Scotia Technical College will connect their 1130 'on-line' to the IBM/360 so that professors and students have access to the 360 via the 1130 instead of transporting cards to Dalhousie. This service will be made available to other universities and organizations as they request the service.

C.2. Remote Terminals

In order for the same services to be available to all computer users regardless of location each user must have his own computer or he must use a remote terminal as a means of access to a large central computer

facility. Communicating through a remote terminal and telephone line, the user receives the same services as if he had a computer on site. This means that one large computer can realistically serve many users separated by distances up to thousands of miles or as close together as offices in a building.

The advantage of having computer terminals is that users, although they are all using the same computer, have the impression that the computer is dedicated to each of them. Three of the attributes of remote terminals that makes this possible are:

1) accessibility of the computer from the remote station

2) fast response time

3) interactive system with the user.

At Dalhousie the computer will be situated in the Killam Library with telephone connections to computer terminals in other campus buildings as well as other locations in the Halifax-Dartmouth area. It is also quite feasible to supply additional computer services to users throughout the province of Nova Scotia.

The most common type of terminal will be a typewriter-like device. However, there are other types of terminals which have more specific application but which are in general use. Among them are:

- card reader, line printer devices

- cathode ray tubes (T.V. screens) commonly called CRT's

- other special purpose computers

Each type of terminal is 'attached' to the central facility by some means. The terminal is able to transmit information over a telephone line by using a data set which takes the character codes and modulates or demodulates them for transmission along telephone lines. Before the information can be handled by the computer the information must be converted back to machine readable form by passing through a second data set. Information reaches the computer from the second data set through a 'port'. The planned configuration is for 15(fifteen) entry ports which are shared among the 'typewriter-like' terminals. No matter what the type of terminal, two data sets are necessary if a telephone line is required (distance requirement). Following is a diagram of the system envisaged at Dalhousie.

C.3. Software Supported

Several software systems are available for System/360. The present installation at Dalhousie operates under Operating System 360 (OS/360) and uses a multiple fixed task operating system (MFT). Due to present core memory limitations the system supports only one problem partition and spools output to the line printer. The programming languages available are Assembler, PL/1, Cobol, Algol, RPG, and Fortran. The computer is operated strictly in a batch mode (programs are queued) because the core is large enough for only one program at a time.

The addition of the LCS (low speed core storage unit, 1,000,000 bytes) will provide enough storage for several problem partitions in the computer. Each partition will be assigned a specific type of job. In addition to supporting the previously mentioned languages the following software systems will be implemented:

C. P. S. (Conversational Programming System)

A. T. S. (Administrative Terminal System)

A. P. L. (A Programming Language)

C.3.1. CPS

The most important new capability will be that of being able to support an interactive (terminal) system. The system chosen is C. P. S. (Conversational Programming System). It is:

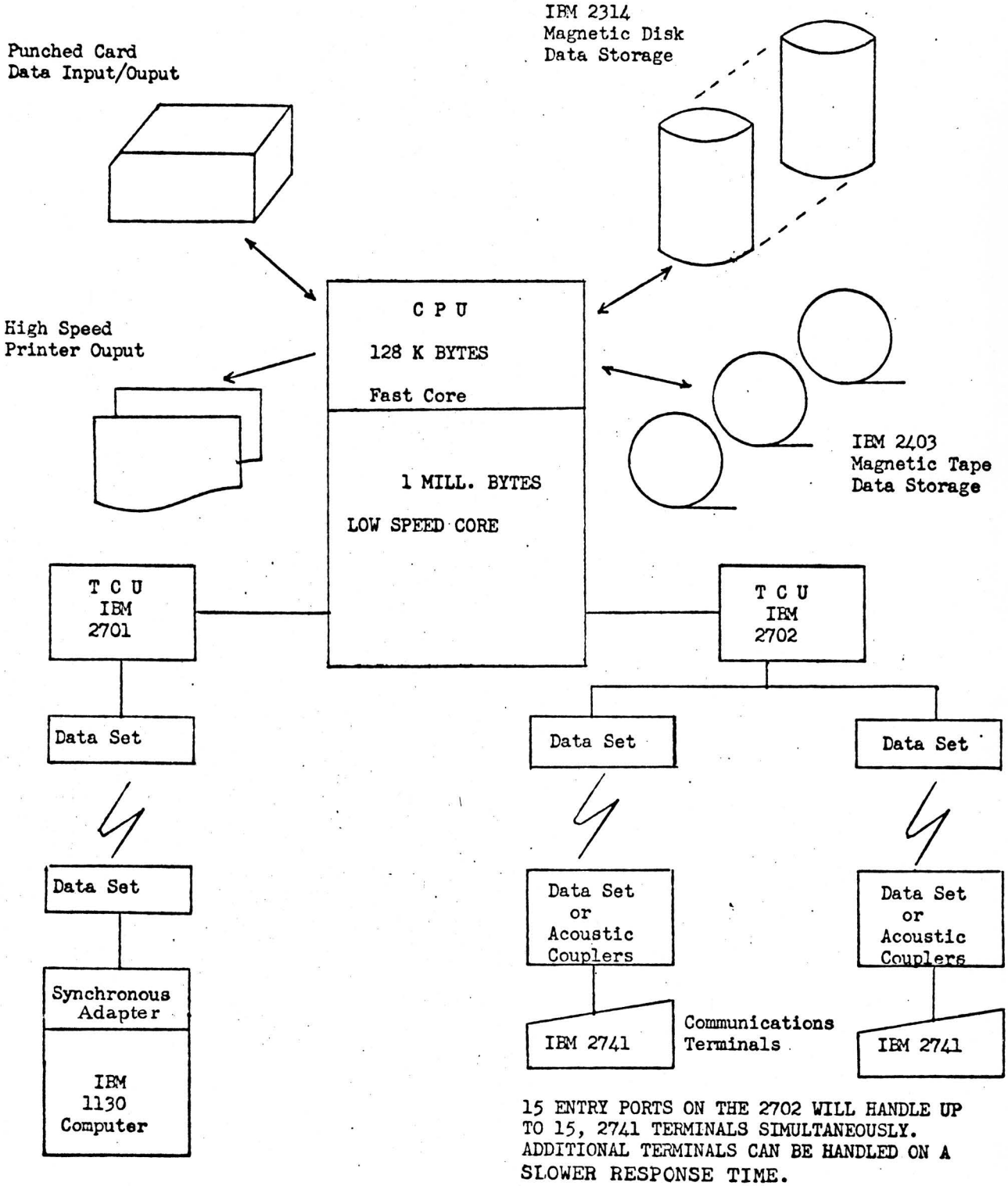
1) a time-sharing system that runs in a partition of the Operating System of the System/360.

2) a conversational subset of the PL/1 language.

3) provides Remote Job Entry for batch processing in another partition of the Operating System.

4) provides Remote Job Output to a terminal designated by any batch processed job.

5) provides a conversational system for the BASIC language (recently announced).



15 ENTRY PORTS ON THE 2702 WILL HANDLE UP TO 15, 2741 TERMINALS SIMULTANEOUSLY. ADDITIONAL TERMINALS CAN BE HANDLED ON A SLOWER RESPONSE TIME.

The user language of CPS is designated for interactive, conversational programming while providing a powerful file manipulation capability from a terminal. It also lends itself readily to the writing and debugging of programs interpretively and to interactive execution of these programs. The PL/1 language subset that is used is very much like the Fortran language. It has many features which are an improvement, among these, file handling and input/output instructions.

C.3.2. Remote Job Entry

The Remote Job Entry (RJE) facility provides the capability to enter programs for processing in this background environment. It is necessary to be familiar with OS/360 batch processing conventions to use RJE. RJE provides: (1) an interface between the terminal and a background partition; and (2) the means to create and update potential input for batch processing in much the same way that one would create and update CPS PL/1 programs. The major difference here is that one creates card images in RJE without syntax checking. The program is submitted as a batch processing job in this environment and syntax checking occurs when compilation is done. This is unlike the interpretive system which gives line-by-line diagnostics as the program is typed in.

C.3.3. Administrative Terminal System (ATS)

The IBM Administrative Terminal System consists of control and functional programs that permit many different data and text-processing activities to be carried on simultaneously through the 2741 terminals. Disk storage is used for the processing storage of all text and data files. This system is particularly relevant to groups who are keeping large files of information that require constant updating and searching. It is this system which has been used extensively by the Faculty of Law, Queens University, by libraries and groups who specialize in report writing and publication.

ATS/360 consists of a group of application programs especially integrated to handle large texts and data files. Data may be entered into the system through the typewriter-like terminal, punch cards and magnetic tape. Data is stored in the form of a text stream. A text stream is any combination of spaces, characters, words, sent-

ences or paragraphs in any sequence and entered at any period of time. It may be assembled at any time for output. The text stream may be outputed directly and a copy of the data reproduced, or it may be read as input to be processed in conventional data processing operations. ATS/360 stores input information in the computer system and returns the information to a terminal or other output device upon demand. Simultaneous operation of a number of remote terminals and CPU I/O devices is possible. Each may be handling a different application. The output may be formatted by specific editing processes selected by the terminal operator and computer operator.

C.3.4. APL

A Programming Language was first described by K. E. Iverson, 1962. It is an interpretive time-sharing system whose structure allows for powerful and concise manipulation of information. It is expected that this interpretive system will be available for use under OS/360 in the near future. Some of the features of the language are:

- simple, uniform rules of syntax
- elegant notation for handling arrays
- a large set of primitive operations
- use of defined functions (programs) with the same facility and syntatic variety as primitive operations
- a comprehensive, integrated set of system commands for managing workspace and libraries and for other essential functions.

The system is currently used over a large range of applications. They vary from simple desk calculations to experimental investigation, laboratory data reduction, development of program models, administration of arithmetic drill to elementary-school children, and to use in graduate-level engineering courses.

The elegant notation and the ease with which this interpretive system can be used has succeeded in appealing to people who previously refused to program.

C.4. Hardware Supported

There are several types of terminals available for use with system/360. The combination of hardware however is limited in most cases by the problem of compatability. A recent visit to NRC in Ottawa has confirmed that a standard terminal and data set appears to be the most flexible combination to the user.

For this reason only the standard IBM 2741 selectric typewriter terminals together with acoustic couplers (a type of data set) available from Maritime Telegraph and Telephone Company will be discussed in detail. In addition the IBM 1130, a computer in its own right, will be supported through a slightly different hardware system (see diagram).

IBM 2741 (Selectric Typewriter)

IBM 1130 (Small Computer)

The IBM 1130 to be used as a terminal to System/360 requires a sychronous adapter. Information is passed to a special high speed data set (the 2741 requires a low speed data set) and then transmitted through telephone lines to a receiving data set. The interface required on the IBM/360 is a Model 2701 which accepts input from the receiving data set.

A variety of terminals as alternatives to the 2741 and 1130 are available through the Maritime Telegraph and Telephone Company. The advantages of these terminals is that they have lower monthly rental and papertape handling facilities.

The disadvantages are: - slower and noisier printing - character set is not flexible - not appropriate for other inter-active systems that may be later supported by the computer centre such as ATS and APL subsystems.

The monthly rentals for the data-com terminals are:

PSR 33	$ 50.00
PSR 35	$ 65.00
ASR 33	$ 95.00
ASR 35	$115.00

C.5. Telephone Services

Telephone Services must be arranged through the local supplier, Maritime Telegraph and Telephone Company. Other users must pay $16.00 per month. An existing telephone line may be used. (Currently, university centrex lines cost $10.00 per month, and business lines, $16.00 per month.)

The provision for leased lines must be made by special arrangements with the University Computer Centre. Distances determine hardware required. Leased lines affect the arrangements made at the central computer facility. Leased lines are available from the telephone company at a monthly rental of $0.08 per fifth of a mile per month, with a minimum charge of $2.40 per month. Installation charge is $6.00. Data sets are needed for all lines of length greater than 4 miles, otherwise data adapters can be used.

C.6. Other Charges

A charge of $100.00 is made at the installation of initial terminal(s) only for each customer for each continuous period. This includes user number assignment and terminal validation.

Customers may change, add or delete established user number(s) and/or terminal validations. A charge of $10.00 will be made for each change or group of changes requested by the customer at one time.

Customers may request the dedicated use of one part into the IBM 2702 controller, on a hard-wired basis, at a rental of $1500 per month (no charge for CPU time).

Customers may rent terminals and adapters directly from IBM or from the Computer Centre. Telephone connections are provided and billed for by the common carrier at its tariffs.

IBM 2741 (typewriter) terminal	91.10 (ed. dis.)	120.50 (others)
Acoustic coupler	35.00	35.00
	126.10	155.50

COMPUTER TIME-SHARING SERVICE
PROPOSED PRICE STRUCTURE
JUNE, 1969

UNIVERSITY COMPUTER CENTRE
DALHOUSIE UNIVERSITY

Use Charges	Users Qualifying for IBM Educational Discount	Other Users
Terminal Connect Time		
8.00 a.m. to 4.00 p.m.	$5.00	6.25
4.00 p.m. to midnight	$3.00	4.00
$/hr. (metered to nearest 0.1 hr)		
Central Processor Time		
$/sec. (metered)	0.05	0.0625
Program Storage		
$/cylinder - month	$5.00	6.00

The monthly use charges are based on actual accumulated usage or recorded by the system during a calendar month, irrespective of the number of terminals used, but subject to a minimum monthly charge of $100.00 per contract.

All users pay the same basic rate, except for the IBM educational discount.

APPENDIX D: SALARY SCALE FOR COMPUTER CENTRES PERSONNEL IN CANADA

MANPOWER ON STAFF	SALARY SCALE	RELATIONS WITH COMPUTING CENTRE	OUTSIDE CONSULTATION	COMPUTING CENTRE TOTAL STAFF	Prof-essional	Other	MANPOWER IN CENTRE	SALARY RANGE	BACKGROUND OF STAFF
3 Systems Analyst	$ 7,740- 9,408	None all done in Library	None	57	26	31	*Manager Infor Ser	11,436-13,896	B.A. Math
	8,964-10,896						Director -1	$18,600 ✓	Ph.D. Physics
	10,896-13,236						Assoc. Director-1	13,800-18,550	M.Sc. Computer Science
2 Library Analyst	11,000-12,950						Sr. Mgr. Syst Dev.	12,600-15,324	M.A. Computer Science
1 Programmer	5,496- 6,684						Sr. Analysts - 8	10,896-13,236	B.Sc.E.E.,M.Sc Math; 4 yrs exp.; B.Comm.; 5 yrs exp.; M.Sc. Comp. Sc.; 5yrs; B.Sc. Chem Eng; M.Sc. Elec. Eng.;
	7,020- 8,532						Analysts - 9	8,964-10,896	M.Sc. Math, M.Sc. Meteorology; B.Sc. E.E.; B.Sc. Math; B.Sc. Physic; 4 years; M.Sc. Comp. Sc M.Sc. Comp Sc.; B.A. Math.
							Systems Analysts-5	7,740- 9,408	B.Sc. Math; 2 yrs; B.Sc. Electrical; 2 yrs; B.Sc. Math.
		UNIVERSITY OF ALBERTA					Programmer-1	5,496- 6,684	1 yr.
							Operations Super-1	9,408-11,436	
							Consul Oper.-4	6,684- 8,532	
							Computer Oper.-5	5,496- 6,372	
							Computer Asst.-5	3,720- 4,992	
							Control Super.-1	7,368- 8,964	
							Control Clerk-1	4,740- 5,772	
							Asst. Cont. Clk-5	3,216- 4,524	
							Key Punch Super-1	5,772- 7,020	
							Key Punch Oper.-4	3,720- 5,496	
							Clerk typists-3	3,372- 4,740	
1 Systems Analyst	$12,000-16,000	Used for Research. Prog. done by Libr. staff. Co-ordinate Planning	Victoria and Simon Fraser	57	28	29	B.A.,B.Sc. plus prog. Experience	$ 7,800 ✓	4-5 Engineering
1 Library Analyst	10,000-15,000								15-M.A. (Math and Physics)
2 Programmer	7.000-10,000						M.A.,M.Sc. plus several yrs	12,500 ✓	13-B.A. ✓ B.Sc.
9 Machine Oper.	4,000- 5,000		UNIVERSITY OF BRITISH COLUMBIA						
1 Clerical	4,500- 6,000						Executives	15,000 ✓	
None		Personal basis relations good	None	11	5	6	Programmer	$ 8,500-11,800	1- Asst. Professor Comp. Sc.
							Prof. Key Punch	3,800- 4,200	1- Ph.D. Physics Comp. Sc.
			BROCK UNIVERSITY				Prof. Comp. Oper.	7,700	1- Math and Elec. Eng.
							Secretary	4,000	1- 7yrs experience. Aerodynamics
									1- Comp. Mfg. Firm
									1- University student.

..2

	MANPOWER ON STAFF	SALARY SCALE	RELATIONS WITH COMPUTING CENTRE	OUTSIDE CONSULTATION	COMPUTING CENTRE TOTAL STAFF	Prof-essional	Other	MANPOWER IN CENTRE	SALARY RANGE	BACKGROUND OF STAFF
1 1	Libr. Systems Ana. Programmer	$13,800-18,550 9,195	No relations Libr. uses services of Admin. Serv. Group.	None	29	15	14	Programmer 1 Programmer 2 Programmer Analyst Programmer Ana. 2 App. Analyst Super. of Data Pro. Key Punch Oper 1 Key Punch Oper 2 Data Control Senior Operator Clerical	$ 5,196- 6,396 6,288- 8,208 7,284- 9,504 8,388-10,848 8,388-10,848 8,388-10,848 3,852- 4,872 4,236- 5,370 5,784- 7,584 6,972- 9,072 3,240- 4,440	2- B.Sc. Math 1- B.Sc. Mech. Engineering 1- C.A. 1- B.Sc.(Appl) 1- B.A.; B.ED. 1- B.A. 1- (Systems Analyst) 12 yrs plus several courses 1- 2 yr. Programmer Course (S.A.I.T.)
				UNIVERSITY OF CALGARY						
2 6 2	Programmer (Systems planning prog. can be paid (Programmer some experience) Machine Operator Clerks	$ 6,500- 8,000 7,500-12,000 7,500 ≠ 3,000- 4,500 3,000- 4,500	Treated same as any education department	None	27	14	13	Director Asst. Professor Managers Programmers Lecturers Tech. writers Cust. Service Consultant Production Super. Machine Operator Key Punch Super Key Punch Oper. Stenographers Secretaries Clerical	$16,000≠ 10,350≠ 9,600-12,200 6,500- 9,900 7,000≠ 6,500≠ 10,200≠ 6,000- 7,600 4,100- 7,500 4,200- 4,800 3,000- 3,640 3,300- 3,900 3,600- 4,800 3,200- 3,600	Ph.D's Masters Managers many years exp. plus Data Processing to Masters degrees Programmers Bachelor's plus bachelors honours elect. Consultant Exp. in Elec. Data Processing. Operators High School Grade 11 or 12 Stenos Business Course
				DALHOUSIE UNIVERSITY						
2 2 2 6 1	Systems Analyst Libr. Syst. Ana. Programmer Machine Operator Clerical	$10,000-12,500 9,000-15,000 6,000- 9,000 3,200- 4,500 3,000- 4,000	Cmtee rel. Libr. Staff on Comp. C. Cmtee also Comp. Cent. on Libr. Committees	Consulted Bill Kurmey $200.00 a day	78	38	40		$ 7,000-20,000 8,000-17,000 8,000-14,000 13,000≠ 9,000-14,000 9,000-16,000 9,000-12,000 9,000≠	6- Mathematics 3- Agriculture 2- Commerce 1- Physics 2- Computer Science 3- Engineering 2- General B.A. 1- General B.Sc. 40- Clerical (Secretaries Key Punch Oper, Comp. Oper., Etc.).
				UNIVERSITY OF GUELPH						

	MANPOWER ON STAFF	SALARY SCALE	RELATIONS WITH COMPUTING CENTRE	OUTSIDE CONSULTATION	COMPUTING CENTRE TOTAL STAFF	Prof-essional	Other	MANPOWER IN CENTRE	SALARY RANGE	BACKGROUND OF STAFF
	NONE		LAKEHEAD UNIVERSITY		22	5	17	Comp. Control Clk Comp. Centre Super Librarian Key Punch Group Leader Key Punch Oper Class A Key Punch Oper Class B Key Punch Oper Class C Comp. Operator Comp. Oper. Trainee	$3,180-4,200 4,500-6,000 3,600-4,800 3,528-4,212 2,964-3,360 3,420-3,804 3,456-4,020 4,380-5,880 3,600-4,500	(Not Available)
	Staff all employed by Computing Centre		LAURENTIAN UNIVERSITY		13	12	1	Director Systems Analyst Key Punch Computer Oper. Programmer Analyst Prog.	$14,000 10,500-12,000 4,000- 5,200 5,000- 5,500 6,000- 9,000 9,000-10,500	Masters of Business Admin. B.A.'s
1 3	Director Key Punch Oper.	$13,345-16,105 3,022- 4,022	Fair agreement	Not normally only once	75	25	50	Programmer Key Punch Oper. Supervisor staff Machine Oper.	$4,900/ 3,000/ 7,500/ 4,000/	Mostly mathematicians (all figures for compt. centre just a guess)
			LAVAL UNIVERSITY							
1 1	Systems Analyst Junior Systems Analyst (Key Punch money available but added when prog. completed)	$11,400/ 4,600- 7,440	Excellent. Centre is service to Univ.-same as library. No charge Centre res. for prog. 1 man allo-oted to Libr.	None	36	14	22	Programmer Data Control Key Punch Supervisors	$ 9,510-12,000 3,180- 4,644 3,852- 4,788 16,500/	1- Applied Science 1- Electrical Engineer 1- Linguistics 2- Math 1- Engineering 1- Law 1- Classics and Foreign L. 2- Masters 1- Ph.D.
				UNIVERSITY OF MANITOBA						

MANPOWER ON STAFF	SALARY SCALE	RELATIONS WITH COMPUTING CENTRE	OUTSIDE CONSULTATION	COMPUTING CENTRE TOTAL STAFF	Prof-essional	Other	MANPOWER IN CENTRE	SALARY RANGE	BACKGROUND OF STAFF
Systems Anal. Syst. Anal. Librarian Programmers Machine Oper.	($35,000 total expenditure)	Excellent	None	60	30	30			Ph.D's Masters Bachelors degrees High School Graduates
			MCMASTER UNIVERSITY						
NONE		Excellent	None	50	20	30	Director Asst. Director Programmers Analysts Operators Key Punch Office Direction Secretaries Stenographers	$20,00 Maximum 3,300- 3,480 3,300- 3,480	B.A. Math and Physics M.A. Engineers
			UNIVERSITY OF MONTREAL						
Library uses resources of computing centre				3	3	-	Director Asst. Director Programmer	$12,000-16,000 10,000-14,000 7,500-10,000	B.A.Sc. in Eng. Physics M.Sc. (Appl) in Elec. Eng. B.Sc. in Math.
			MOUNT ALLISON UNIVERSITY						
No facilities in library			UNIVERSITY OF NEW BRUNSWICK						Dr. Tremblay of Computing Centre to have info. by the
Clerical 1/12 Syst. Ana. 1/12 Libr. Ana employed by Comp. Centre)	$ 3,480- 4,608	Very Good	Not directly meets other librarians occasionally	52	14	38	Prog. Admin-1 Prog. Admin-2 Prog. Admin-3 Director Key Punch Comp. Oper-1 Comp. Oper-2 Comp. Oper-3	$ 6,800- 9,500 8,300-11,500 10,800-13,800 16,300-23,600 3,400- 5,300 4,200- 5,500 5,100- 6,700 6,200- 8,600	Mathematicians Electrical engineers
			UNIVERSITY OF OTTAWA						

MANPOWER ON STAFF	SALARY SCALE	RELATIONS WITH COMPUTING CENTRE	OUTSIDE CONSULTATION	COMPUTING CENTRE TOTAL STAFF	Prof-essional	Other	MANPOWER IN CENTRE	SALARY RANGE	BACKGROUND OF STAFF
1 Junior Clerks 1 Intermediate Clks	$ 3,000- 3,500 3,600/	Very good	None	58	24	34	Sr. 5- Managers 16-Programmers 1- Systems Anal. 2- Consultants	$13,000-19,000 5,000-10,500 9,000-11,800 11,000-15,000	7- B.A.'s 7- Bachelor of Science 1- Master of Bus. Admin. 1- Bachelor of Engineeri
QUEENS UNIVERSITY									
1 Library Systems Analyst 1 Library Junior 2 Key Punch	$11,200-14,200 7,500-10,300 3,876- 5,436	Excellent Programming done by centre. 1 man loaned to library	None. But Expect a Blue Ribbon Team from I.P.C.U.R.	36	15	21	Professional Clerical	$ 6,000-12,000/ 4,212- 7,200	9- Gr. XII / on job trai 5- B.A. Math 2- Engineering Elec. 1- Business Admin.
UNIVERSITY OF SASKATCHEWAN									
None		Good	Laval Library				(It has been impossible for them to give us any figures at this time they will try to do so within next week or so and mail to us)		
SHERBROOKE UNIVERSITY									
1 Systems Analyst 1 Libr. Analyst	$ 8,888-11,928 5,720- 7,200	Progr. done by Comp. Centre	Victoria & UBC. Used I.B.M. at beginning not satisfae-tory.	48	19	29		$ 6,600-12,600	Statistician Mathematician Graduates B.C. Inst. of Technology.
SIMON FRASER									
1- Systems Analyst	Employed by Comp. Centre	Good	Yes	30	15	15	Managers Machine Oper Key Punch Oper. Clerical Programmer Systems Analyst	$15,000 5,000- 6,000 4,500- 6,000 4,000- 5,500 6,000- 9,000 9,000-13,000	Univ. Comp. Degrees Junior College Clerical - High School Programmers and Systems univrsity degrees and with experience.
SIR GEORGE WILLIAMS UNIVERSITY									

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MANPOWER ON STAFF	SALARY SCALE	RELATIONS WITH COMPUTING CENTRE	OUTSIDE CONSULTATION	COMPUTING CENTRE TOTAL STAFF	Prof-essional	Other	MANPOWER IN CENTRE	SALARY RANGE	BACKGROUND OF STAFF
2 Kep Punch Oper. 3 Machine Operator 2 Programmers 2 Systems Librarian	$3,600- 4,450 4,750- 8,000 4,750-11,150 7,300/	Prog. done by Library	Occasionally	70	25	50	5- Managers Programmer Operational Staff Clerical.	$15,000-20,000 8,000-15,000 5,000-12,000 4,200- 6,000	Mathematicians Applied Mathematicians Engineers Engineering Sciences Social Science & Humanitie
		UNIVERSITY OF TORONTO							
NO COMPUTING FACILITIES RECORDS		DONE BY G.C.E.	TRENT UNIVERSITY						
1 Systems Analyst 1 Programmer 1 Key Punch	$10,000/ 3,732/ 5,000-6,100	All prog. done by Computing Centre	U.B.C. and Simon Fraser	38	24	14	Junior Programmer Prog. Analyst Sr. Programmer Supervisor	$ 5,820- 7,740 5,520- 8,920 8,500-10,800 9,600/	1- No degree 5- B.A.'s 3- B.Sc. Math & Physics 3- B.Sc. Math 2- M.Sc. Statistics 1- M.Sc. Psychology 1- M.Sc. Physics 1- M.Sc. Math 2- M.Sc. Engineering 1- Ph.D. Chemistry 1- Ph.D. Physics
			UNIVERSITY OF VICTORIA						
1 Systems Research Assistant	$5,210/	Largely done by Comp. Centre Mr. Bean Asst. Libr. does some prog. Relations good.	Not as yet	(FOR COMPUTING CENTRE SEE ATTACHED LIST)					
			UNIVERSITY OF WATERLOO						
1 Libr. Analyst 1/3 Systems Ana. 1 Programmer 6 Machine Operators 2 Junior Clerks 1 Senior Clerk	$ 7,600- 8,500 Empl. by comp. c. 3,205- 4,450 3,700- 5,200 4,450- 6,300	Excellent. Systems Libr. meets with them daily	Yes- I.B.M. with Data Proc. & Syst. Dev.	30	6	24	4- Systems Anal. 1- Asst. Director 1- Director	$ 8,000-10,000 15,000-16,000 19,000-21,000	1- Chartered Accountant 1- Master of Bus. Admin.
			UNIVERSITY OF WESTERN ONTARIO						

	MANPOWER ON STAFF	SALARY SCALE	RELATIONS WITH COMPUTING CENTRE	OUTSIDE CONSULTATION	COMPUTING CENTRE TOTAL STAFF	Prof-essional	Other	MANPOWER IN CENTRE	SALARY RANGE	BACKGROUND OF STAFF
1	Systems Analyst	$10,500/	Partly	Yes. Not	17	16	1	Director		7- B.A.'s
1	Libr. Analyst	16,000/-	Centre and	systematic.				Programmer	$ 7,000-10,000	3 have 1 1/2 university
2	Machine Operator	4,200-5,200	partly	Have resident				Oper. Staff	5,000-10,000	
1	Clerk	4,000	systems	I.B.M. man				Clerical	3,500	
			analyst.	in accounts						
			Relations	UNIVERSITY OF						
			very good	WINDSOR						
1	Systems Analyst	$10,000-12,000	Relations	yes - informal	34	14	20	Programmer	$ 5,500-12,000	2- Ex. Teachers.
1	Libr. Analyst	10,000-12,000	good	discussions				Data Control	5,000-10,000	4- Computer Science
	Programmer	Not empl. by						Key Punch	7,000(just a	1- Mathematician
		library							guess)	
1	Asst. to Libr.							Supervisor Systems		
	systems Analyst	10,000-12,000		YORK UNIVERSITY				Analyst	10,000-14,000	
2½	Clerks	3,500- 5,000								

UNIVERSITY OF WATERLOO COMPUTING CENTRE

I. CONSULTING:

(1) Senior Consultant (1)
M.A. - 1 yr. on job $10,400

(2) Consultants (2)
M.Sc. - 1 yr. on job $10,600
1 yr. experience as systems analyst
M.Math - 3 yrs. on job $10,500

(3) Associate Consultants (2)
B.Sc. - 1 yr. on job $8,000
B.Sc. - 1 yr. on job $7,300

II. DATA PROCESSING:

(2) Managers (3)
Ph.D. - 2 yrs. on job $20,000
6 yrs. experience as professor and systems research
Ph.D. - 3 yrs. on job $19,300
5 yrs. experience on computer research
M.A. - 3 months on job $16,000
2 yrs. experience in programming supervision

(3) Supervisors of Systems Analysis (2)
B.A.Sc. - 2 yrs. on job $14,000
M.A. - 2 yrs. on job $13,200

(4) Senior Systems Analysts (4)
M.A. - 3 yrs. on job $13,400
M.A. - 3 yrs. on job $12,000
M.A. - 3 yrs. on job $11,600
M.A. - 1 yr. on job $ 9,500

(5) Junior Systems Analysts (7)
- no university - 4 yrs. on jobs $9,100
  2 yrs. experience as operator
- 1 yr. university -2 yrs. on job $9,100
- B.A. - 2 yrs. on job $9,100
  2 yrs. experience programming
- B.A. - 6 months on job $8,400
- 2 yrs. university -2 yrs. on job $8,100
- B.A. 1 yr. on job $8,000
  6 months experience programming
- B.A. - 2 yrs. on job $7,400

(6) Supervisor of Programming (1)
- no university - 3yrs. on job $15,000
  12 years experience as programmer and supervisor

(7) Senior Programmers (6)
- Technical 3 yr. Diploma - 2 yrs. on job $11,600
  6 yrs. experience as programmer and technological engineer
- no university - 3 yrs. on job $11,000
  5 yrs. experience as programmer
- no university - 2 yrs. on job $11,000
  11 yrs. experience as programmer and operator
- B.Sc. - 2 yrs. on job $9,900
  2 yrs. experience as programmer
- M.A. - 3 yrs. on job $9,900
- B.Sc. - 2 yrs. on job $9,700

(8) Junior Programmers (5)
- B. Math - 8 months on job $8,100
- B.Sc. - 3 months on job $8,000
- B.Sc. - 3 months on job $8,000
  2 yrs. experience as programmer
- 1 yr. university, 2 yrs. on job $7,600
  1 yr. experience as programmer
- B.Math. - 6 months on job $5,700

(9) Supervisor of Operation (2)
- no university, 3 yrs. on job $14,400
  3 yrs. experience as programmer
- B.Math., 4 months on job $8,000

(10) Senior Computer Operators (8)
$5,000 - $9,000

(11) Junior Computer Operators (6)
$4,000 - $5,000

(15) Senior Operator U/R Equipment (1)
$5,700

(17) Keypunch Supervisor (1)
$5,000

(18) Senior Keypunch Operators (5)
$4,300 - $5,000

(19) Junior Keypunch Operators (6)
$3,300 - $4,100

(20) Supply Librarians (2)
- B.A. - 1 yr. on job $7,300
- B.A. - 1 yr. on job $6,300

III. ENGINEERING (2) Senior Engineer (1)
-M.A.Sc. - 1 yr. on job $9,500

IV. INSTRUCTION

(2) Instructors (3)
- B.A. - 6 months on job $8,000
- B.A. - 1 yr. on job $7,700
- B.A. - 1 yr. on job $7,200

V. OPERATIONS RESEARCH

(2) Operations Research (2)
- M.A. - 3 months on job $12,500
  5 yrs. experience as analyst and programmer
- Ph.D. - 3 months on job $11,000

4 administrators $6,000 - $9,500
8 secretaries
23 summer employees
12 part-time employees

The University of Calgary

Data Centre Personnel

Job Classifications	Salary Ranges	# of Encumbents	Backgrounds
Manager		1	
Manager, Information Systems	$12,150-15,325/annum	1	B.Sc., M.Sc. (Information Science)
Operations Manager	$12,150-15,325/annum	1	Tab Course Diploma
Scientific Programmer III	$10,300-13,350/annum	5	1. B.Sc.(Physics), M.Sc.(Meteorology) 2. B.Sc. (Engineering) 3. B.A. (Philosophy) 4. B.Sc.(Mathematics) 5. B.Sc.(Physics), M.Sc.(Physics), Ph.D. (Chemical Physics)
Scientific Programmer II	$9,000-11,850/annum	4	1. B.A. (Honours) 2. B.Sc.(Mathematics) 3. B.Sc.(Agriculture), M.Sc. (Agr. Economics) 4. B.Sc.(Mathematics), M.Sc. (Computing Science)
Scientific Programmer I	$524-685/month	3	1. B.Sc.(Mathematics) 2. B.A. 3. B.Sc.(Mathematics)
Applications Analyst	$699-904/month	1	Engineering degree
Admin. Programmer II	$524-684/month	1	See attached job description
Work Station Supervisor	$626-829/month	1	" " " "
Services Supervisor	$626-829/month	1	" " " "
Shift Supervisor	$578-765/month	3	" " " "
Computer Operator II	$498-623/month	2	" " " "
Computer Operator I	$412-517	6	" " " "
Computer Operator Trainee	$340-412	3	" " " " (unavailable)

Job Classifications	Salary Ranges	# of Encumbents	Backgrounds
Work Station Operator	$412-517/month	1	See attached job description (unavailable
Dispatch Clerk	$257-317/month	1	" " " " "
Utility/Driver	$391-451/month	2	" " " " "
Library Assistant II	$353-448/month	1	" " " "
Keypunch Operator I	$321-406/month	2	" " " "
Secretary Stenographer II	$412-517/month	1	" " " "
Secretary Stenographer I	$353-448/month	1	" " " "
Clerk Typist II	$289-364/month	2	" " " "
Clerk I	$257-317/month	2	" " " "
	Total	46	

August 15, 1969.