



SCHOOL ADMINISTRATION AND  
THE MICROCOMPUTER

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In Partial Fulfillment  
of the Requirements for the Degree  
Master of Education

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by  
Vernon August Barrett  
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VERNON AUGUST BARRETT

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the University of Manitoba in partial fulfillment of the requirements  
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## ABSTRACT

The major purpose of this study was to determine what variables were involved in the administrative use of microcomputers in schools, and how these variables were being accounted for in Winnipeg schools. Questionnaires were initially mailed to all 46 high schools in the Metro Winnipeg area. Completed questionnaires were received from 41 schools (89%). From these results, six schools were identified as presently employing the microcomputer for administrative use, and personnel in these schools were interviewed during personal visits.

The major conclusions reached in the study are as follows:

I. The great potential which exists for administrative use of the microcomputer has not been developed significantly by Winnipeg high schools.

II. Operating software available to microcomputer users is varied but adequate.

III. Since administrative software up to the time this study was conducted has been commercially available to only a limited extent, Winnipeg high schools attempted to develop their own - with very limited success.

IV. In general, Winnipeg high schools have not acquired the necessary microcomputer hardware to facilitate administrative applications.

V. While the costs of microcomputer based administrative services may be high, up to this point expenditures by Winnipeg high schools in this area have been relatively

limited.

VI. The role of the Winnipeg administrator has yet to be affected by the microcomputer.

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## TABLE OF CONTENTS

	Page
LIST OF TABLES .....	xii
LIST OF FIGURES .....	xiii
Chapter	
I. INTRODUCTION .....	1
Research Problem .....	2
Study Purpose .....	2
Research Questions .....	2
Significance of the Study .....	4
Limitations .....	5
Delimitations .....	6
Definitions .....	6
Methodology .....	7
II. REVIEW OF THE LITERATURE .....	9
The Computer .....	9
Characteristics of a Computer .....	9
The Central Processing Unit .....	10
Data Input .....	11
Data Output .....	12
External Storage .....	12
Software .....	13
Characteristics of a Microcomputer .....	14
The MPU or CPU .....	14
Data Input .....	16



Chapter	Page
II.	
Data Output .....	16
External Storage .....	16
Software .....	17
Differences Between Large Computers and Microcomputers .....	18
Administrative Functions of Microcomputers .....	22
Research Question #1, Applications .....	22
Functions of School Administrators .....	22
Computers and School Administration .....	25
Management Systems .....	26
Student Data .....	28
Census .....	28
Attendance Accounting .....	29
Pupil Progress Reporting .....	29
Microcomputers and School Administration ..	30
Restrictions due to the Nature of the Microcomputer .....	31
Most Feasible Administrative Applications .....	34
Conclusion: Research Question #1, Applications .....	37
Software .....	37
Research Question #3, Software .....	37
Operating Software .....	38
Operating System .....	38
Computer Language Software .....	39
Conclusion: Research Question #3 (a), Software .....	39

Chapter	Page
II. Application Software .....	41
Conclusion: Research Question #1 (b), Software .....	44
Hardware .....	44
Research Question #5, Hardware .....	44
Findings .....	44
Conclusion: Research Question #5, Hardware .....	48
Costs .....	49
Research Question #7, Costs .....	49
Findings .....	49
Time .....	49
Resources .....	53
Personnel .....	56
Conclusion: Research Question #7, Costs ..	59
Administrative Roles .....	59
Research Question #9, Administrative Roles .....	59
Findings .....	59
Decision Making .....	60
Management Concerns .....	61
Instructional Concerns .....	62
Societal Concerns .....	62
Conclusion: Research Question #9, Administrative Roles .....	63
Summary .....	64

Chapter	Page
III. RESEARCH DESIGN AND METHODOLOGY .....	67
Research Design .....	67
Conceptual Framework .....	67
Applications .....	68
Research Question #1 .....	68
Research Question #2 .....	68
Software .....	68
Research Question #3 .....	68
Research Question #4 .....	68
Hardware .....	68
Research Question #5 .....	68
Research Question #6 .....	70
Costs .....	70
Research Question #7 .....	70
Research Question #8 .....	70
Administrative Roles .....	70
Research Question #9 .....	70
Research Question #10 .....	70
Respondents .....	70
Instrument Development .....	71
Research Methodology .....	71
Data Treatment .....	72
IV. PRESENTATION AND ANALYSIS OF DATA: Administrative Use of Microcomputers in Winnipeg Schools .	73
Questionnaire Results .....	73

Chapter	Page
IV. Interview Results .....	75
Administrative Microcomputer Applications in Winnipeg High Schools .....	82
Research Question #2, Applications .....	82
Findings .....	82
Existing Administrative Applications .....	82
Comparison of Hardware and Expectations ..	85
Conclusion: Research Question #2, Applications .....	89
Software Used by Winnipeg High Schools .....	90
Research Question #4, Software .....	90
Findings .....	90
Conclusion: Research Question #4, Software ...	91
Hardware Used by Winnipeg High Schools .....	92
Research Question #6, Hardware .....	92
Findings .....	92
Microcomputers .....	92
Methods for External Storage .....	93
Printers .....	93
The Minicomputer of School #4 .....	94
Conclusion: Research Question #6, Hardware ...	94
Costs of Using the Microcomputer for Administration in Winnipeg High Schools .....	95
Research Question #8, Costs .....	95
Findings .....	95
Conclusion: Research Question #8, Costs .....	98

Chapter	Page
IV. Changes in the Role of the Educational Administrator in Winnipeg High Schools ...	99
Research Question #10, Administrative Roles ..	99
Findings .....	99
Conclusion: Research Question #10, Administrative Roles .....	99
Comparison of the Literature and the Field .....	100
Administrative Functions .....	100
Software .....	103
Hardware .....	105
Costs .....	106
Administrative Roles .....	109
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS ..	110
Summary .....	110
Study Purpose, Focus, and Problem Statements .	110
Purpose .....	110
Focus of the Study .....	110
Study Respondents .....	112
Instrument Development .....	112
Data Collection .....	112
Data Treatment .....	113
Summary of Research Findings .....	113
Applications .....	113
Software .....	114

Chapter	Page
V. Hardware .....	115
Costs .....	115
Administrative Roles .....	115
Conclusions .....	116
Recommendations .....	117
Suggestions for Further Study .....	118

#### APPENDICES

A. Glossary of Computer Terms .....	A-1
B. Letter of Transmittal .....	B-1
C. Questionnaire .....	C-1
D. Interview Schedule .....	D-1
E. Seven Oaks Duties of Principals .....	E-1

#### BIBLIOGRAPHY

LIST OF TABLES

Table	Page
I. Comparison of Large Computers With Microcomputers .....	19
II. Administrative Functions For General Computer Use .....	27
III. Potential Microcomputer Administrative Applications .....	32
IV. Canadian Consumer Concerns Re: Microcomputers .....	35
V. Mandatory/Desirable BASIC Language Features .	40
VI. Examples of Microcomputer Administrative Capabilities .....	46
VII. Responses to Request for Proposal .....	55
VIII. Correlation of Literature Findings With Second Research Question in Each Area .....	69
IX. Investigation Areas and Interview Schedule ..	71
X. Results of Questionnaire on Microcomputer Use .....	74
XI. Possible, Feasible, and Actual Microcomputer Uses for Administration in Winnipeg High Schools .....	84
XII. Summary of School Hardware and Expectations .	86
XIII. Anticipated and Actual Costs with School-based Micros for Administrative Use .	96
XIV. Correlation of the Literature with the Field in Each Area .....	101

LIST OF FIGURES

Figure	Page
1. Schematic of a Computer .....	10
2. A Microcomputer System .....	15



CHAPTER I  
INTRODUCTION

The age of the microcomputer is upon us as we enter the 1980's. While the first microprocessor chip, the Intel 4004, appeared as recently as 1971<sup>1</sup>, microcomputer manufacturers have since seized every opportunity to accelerate further technological developments. Succeeding advancements in silicon chip technology facilitated the production of systems characterized by small physical size, but possessing astounding capabilities. This increase in microprocessor unit (MPU) capability along with new technical developments, mass production, and the competitive marketplace, has led to a reduction in the cost of microcomputer units. The impetus towards microcomputers has been further enhanced by the improved dependability achieved with advances in solid-state technology, microcircuitry, and modular construction methods. All of these factors have been instrumental in promoting the development and extension of microcomputer applications in many new areas.

Despite the rapid growth of the industry, microcomputer uses for education have developed rather slowly. While it might be argued that the rapid developments in computer technology have made it difficult for educators to keep abreast of recent changes, it is clear that similar

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<sup>1</sup> Timothy J. Thompson, "An Overview of Microprocessor Central Processing Units (CPU)", Educational Technology, October 1979, p. 41.

difficulties for homes and businesses across North America are being swiftly surmounted by an intrigued and thirsting population. Whether schools are able to keep pace with this vigorous movement may be almost entirely dependent upon the adaptabilities of school administrators.

Formerly, the high costs of computer use restricted educational applications to large systems and packaged programs. In this context numerous school boards and departments of education either employed programmers to instruct leased computers, or submitted data directly to a contracted computer service. The recent developments in the scope and cost of microcomputers have now created an abundance of possible administrative applications for the individual school. In fact, manufacturers are currently marketing systems capable of storing and editing records, class schedules, student timetables, master timetables, attendance files, and budget entries. The challenge becomes for school administrators to utilize this new technology in an efficient and effective manner.

#### Research Problem

#### Study Purpose

The purpose of this study was to determine what variables are involved in the administrative use of microcomputers in schools, and how these variables are being accounted for in Winnipeg schools.

#### Research Questions

In order to meet the purpose of the study, research

questions were identified in the context of the following areas related to the administrative use of computers in schools.

#### Applications

1. What administrative applications of the microcomputer are suggested in the literature by the authorities?

2. To what extent is the microcomputer being used for administrative purposes in Winnipeg schools?

#### Software

3. a) What operating and application software is available, and which of these are recommended in the literature?

b) What sources of software exist for the prospective user in Manitoba?

4. What software is being used for administrative functions by Winnipeg schools?

#### Hardware

5. What are the options in microcomputer hardware available for administrative use in schools, and which of these are recommended in the literature?

6. What hardware is being used and recommended by Winnipeg schools using the microcomputer for administrative purposes?

#### Costs

7. What is the cost in time, resources, and personnel to those schools using computer based administrative services?

8. What costs in terms of time, resources, and personnel have been borne by Winnipeg schools using the

microcomputer for administration?

Administrative Roles

9. What implications will the advent of the microcomputer have upon the role of educational administrators?

10. What implications has the microcomputer had for the role of the educational administrator in Winnipeg high schools?

Significance of the Study

In recent years, there has been renewed interest in integrating the computer, in particular the microcomputer, into both the curricula and school level administrative functions. It is no longer a question of "whether" the computer should be used at the administrative or instructional level in schools, but rather one of "how" the integration of the computer into various school functions will occur. It follows, therefore, that the challenge for educational administrators is to accept the inevitable presence of computers in schools, become computer literate, and direct microcomputer use so as to serve the best interests of education.

In the province of Manitoba there have been no studies reported in the area of administrative microcomputer use by individual schools. Such a study should assist school administrators in meeting the challenge of using microcomputers for administrative functions.

It is therefore the purpose of the present study to address the specific case of the administrative use of

microcomputers in schools in order to:

I. Identify from the literature relevant information on the computer and microcomputer in order to build a historical framework.

II. Indicate to what extent Winnipeg schools had progressed in using the microcomputer for administration.

III. Indicate which microcomputers had been found to be suitable for administrative functions by Winnipeg schools.

IV. Establish background information regarding the "state of the art" for further research in this area.

#### Limitations

This study relied on (1) published literature and research for information concerning present uses and recommendations in North America, and (2) perceptual and observational data regarding administrative use of computers in Manitoba schools.

The research pertaining to the use of microcomputers for administrative functions in Manitoba schools was dependent upon both the interpretation of questions by the respondents, as well as the interpretation of responses by the interviewer.

A further limitation was imposed due to the newness of the field being investigated. While microcomputer use is now rapidly developing in Manitoba, this was not the case when research data was gathered. Consequently, what was true when this study was undertaken may no longer be true at the time of completion.

### Delimitations

This study was intended to reflect conditions as they existed prior to the spring of 1982.

Further restrictions imposed by the author included directing the questionnaire examining microcomputer use only to principals of Winnipeg high schools, as well as confining the content and discussion of same to the administrative use of microcomputers.

### Definitions

Microcomputer - These units are portable, cost from \$200 to \$8,000, usually possess main memory of 64K or less, and are capable of a wide variety of applications ranging from computer games to small business accounting.

Minicomputer - Computer systems which are more difficult to move, cost from \$20,000 to \$500,000, but feature a much larger machine memory and impressive speed.

Mainframe - This term was used to refer to a large computer system housed permanently in a central location, costing about a million dollars, and capable of handling large data bases using complex file manipulations while demonstrating incredible speed.

For a more comprehensive list of definitions, the reader is referred to Appendix A: A Selected Glossary of Terms Useful in Dealing With Computers.<sup>2</sup>

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<sup>2</sup> Charles H. Douglas and John S. Edwards, "A Selected Glossary of Terms Useful in Dealing With Computers", Educational Technology, October 1979, p. 62.

### Methodology

Two research and data-gathering steps were required in order to address the research problem: (1) an examination of the literature and research in the area of microcomputer use for administration in order to deductively derive a conceptual framework with which to examine the administrative use of microcomputers in Winnipeg high schools; and (2) the gathering of descriptive and perceptual data regarding the use of microcomputers for administration in Winnipeg high schools.

While a wide range of literature related to microcomputers in school administration was examined, particular attention was accorded to sources in the following five areas:

1. Administrative Functions of Computers and Microcomputers
2. Microcomputer Software
3. Microcomputer Hardware
4. Microcomputer Costs (time, resources, personnel)
5. Microcomputers and Changing Administrative Roles.

A microcomputer questionnaire (Appendices B and C) was sent to Metro Winnipeg High Schools and resulted in the identification of schools involved in the administrative use of microcomputers. Subsequent personal interviews were conducted with personnel in each of these schools using the Interview Schedule included in Appendix D as a guide.

Finally, the major analytical component of the thesis involved the comparison of the user variables as identified

in the literature with the user variables in the field in order to address the major problem statement.

In this chapter, the main research problem and research questions investigated in the study, limitations, delimitations, definition of terms used in the study, and methodology were presented. The remainder of the thesis was organized as follows:

- Ch. 2 - Review of Related Literature
- Ch. 3 - Research Design and Methodology
- Ch. 4 - Presentation and Analysis of Data
- Ch. 5 - Summary, Conclusions, and Recommendations



## CHAPTER II

### REVIEW OF THE LITERATURE

In this chapter, related literature is examined in order to identify (1) the unique characteristics of the microcomputer, and (2) variables regarding the use of the microcomputer for performing administrative functions in schools. In the first section of this chapter, common computer characteristics are discussed in order to place the administrative use of microcomputers in the context of the broader issue of computers in general. In the second section, the administrative use of computers is examined under the following headings: (1) administrative functions; (2) software; (3) hardware; (4) costs; and (5) administrative roles. The intent of this chapter is to construct a framework which may be used to examine microcomputer use for administration in Winnipeg high schools.

#### The Computer

##### Characteristics of a Computer

While a variety of definitions of the term "computer" exist in the literature, Spencer's comparatively simple assertion that a computer "is a machine for performing complex processes on information without manual intervention"<sup>3</sup> will be considered sufficient for this paper. Within this framework, then, would be included electronic data processing

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<sup>3</sup> D. D. Spencer, *Computers in Society*, (Rochelle Park, N.J.: Hayden, 1974), p. 6.

machines, EDP processors, as well as any other device which represents numerical quantities by discrete electrical states and can be manipulated logically and arithmetically.

All varieties of computer, regardless of make or design, require both physical equipment (hardware) and programs or instructions (software). Elements common to a computer's hardware are a Central Processing Unit (CPU), a method for data input, a method for data output, and an external storage capability (Figure 1.)

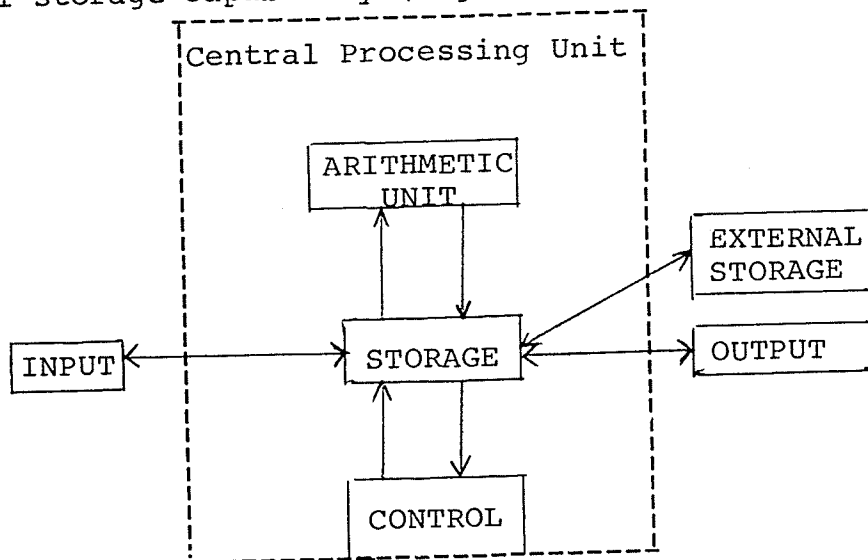


Figure 1  
Schematic of a Computer

SOURCE: D. Moursund, School Administrator's Introduction to Instructional Use of Computers, International Council for Computers in Education, (Eugene, Oregon: University of Oregon, 1980), p. 8.

The Central Processing Unit, or CPU, is commonly referred to as the "brain" of the computer since it controls decisions, performs arithmetic operations, and contains the machine's internal memory.

While the function of the CPU has remained relatively

constant throughout the years, the technology utilized in its construction has not. The magnetizable ferrite washers or "cores" suspended on a lattice of crossed wires common to the sixties were quickly outmoded by advances in solid-state conductor memory and integrated circuits. Similarly, recent development of the silicon "chip" has resulted in semiconductor memory becoming rapidly obsolete.

Whatever the technology employed, the CPU may be visualized as a series of "on-off" switches or states, each of which is regarded as a "bit" of information. Six to eight bits in a row are referred to as a byte and are used by the machine to represent one alphabetic, numeric, or special symbol. Different manufacturers use a string of from one to eight of these bytes to represent a computer "word".

Due to the nature of the on-off storage employed, the computer changes all information into BINARY (base-two) numbers before placing it in storage. It is of interest to note that all logical and arithmetic operations are performed in binary with the results converted back to alphabetic or base-ten (decimal) format before output to the user.

Data input to a computer may be accomplished by a number of devices which convert the given information into binary format to be stored in memory. While the most common form of input has been the punched card, additional devices capable of this function are the paper tape reader, optical scanner, magnetic ink character reader, and keyboard.

Data output is most often performed by means of a line printer, which forms numerals, letters, or other characters on continuous rolls of paper. Other output devices in common use are the card punch, paper tape punch, and cathode ray tube (CRT or TV).

External storage capability refers to the ability of a computer to store masses of data outside the CPU, and to transfer this information between central memory and the external storage device as required. The most common storage devices use magnetic recording surfaces applied to drums (spinning cylinders), rigid discs (hard plastic spinning discs), floppy discs (flexible plastic spinning discs), and magnetic tapes. While core, drum, and disc memories allow for random access (RAM), the nature of magnetic tape restricts its use to a serial access format. Hence, to acquire the information in the 500th word on tape, 499 words must first be read.

Clearly the access speed, or time required to find and retrieve a word from memory, will vary with each type of external storage device. It should be noted, however, that since the average access time of rigid discs is .010 seconds while that of CPU memory is .0000004 seconds, the internal storage capability of a computer is of prime importance to users.<sup>4</sup>

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<sup>4</sup> R.C. Dorf, Computers and Man, (San Fransisco: Boyd and Fraser, 1977), pp. 119 - 127.

Software is the term used to refer to the combination of Operating System and applications programs.

An Operating System controls the functioning of the computer after transforming or compiling the computer language instructions into machine code. While a large computer may be supplied with compilers for many languages (eg. Fortran, Cobol, Algol, PL1, and BASIC), microcomputers normally support only one language but possess expansion capability. All computers perform instructions sequentially, but while microcomputers typically interpret and execute only one instruction at a time, larger computers are able to execute many programs simultaneously. One example of such a large computer is the IBM System 360 Model 195, a machine capable of processing instructions at the rate of one every 54 billionths of a second, or the time that light, travelling at the rate of 186,281 miles per second, can move 53 feet. This multi-million dollar machine can solve 15 problems simultaneously, store the contents of more than 3 million books, and locate and read any one of the books in less than one second.<sup>5</sup>

Applications programs instruct the computer, in a given computer language, to perform specific steps in order to attain a desired outcome. Although the majority of the required programs could be created on site, users often elect to purchase these products when commercially available.

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<sup>5</sup> D.D. Spencer, op cit., p. 166.

In any case, good-quality, well-documented applications software is a high priority among computer users.

However powerful a computer appears to be, there exist some very real and critical limitations on its actual abilities. A computer cannot think, create, infer, discriminate, or make value judgements. In the words of President John F. Kennedy, May 21, 1963, when he welcomed back astronaut Gordon Cooper: "However extra-ordinary computers may be, man is the most extra-ordinary computer of all".<sup>6</sup>

#### Characteristics of a Microcomputer

A microcomputer system is a modular arrangement of a number of interacting components, some of which may be enclosed in a single container (see Figure 2).

As with other computers, microcomputers require both hardware and software, and the standard components in a microcomputer system are: a Microprocessor Unit (CPU or MPU), a method of data input, a method of data output, and an external mass storage device.

The MPU or CPU consists of one or several large scale integrated circuits, existing on "chips" of silicon, and located within the main computer housing where they are mounted on circuit boards. These same integrated circuits also provide the internal memory of the microcomputer in both the Random Access (RAM) and Read Only (ROM) forms.

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<sup>6</sup> Ibid, p. 5.

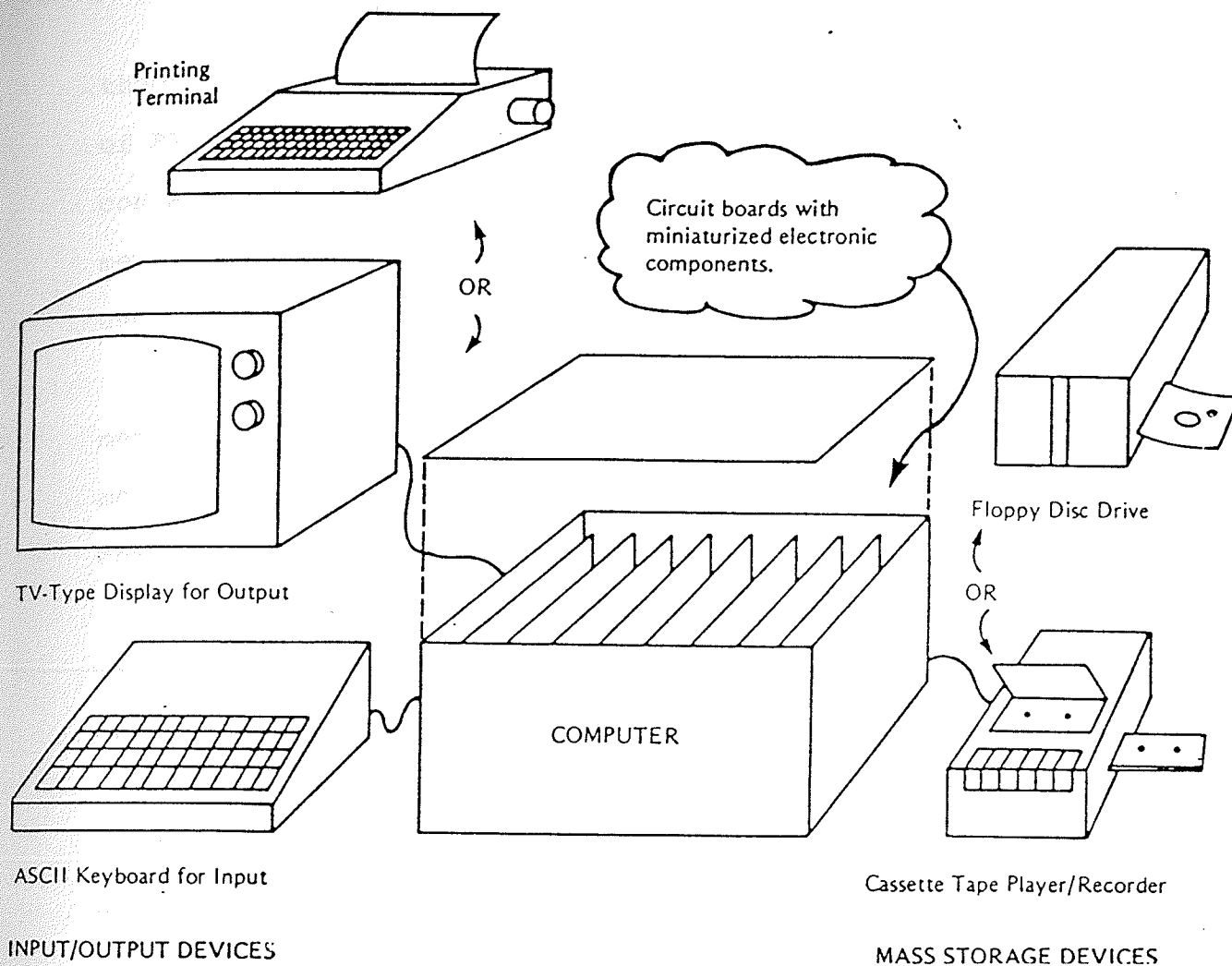


Figure 2

A Microcomputer System

Source: William C. House and James E. Shankle, "Choosing the Right Microcomputer", Journal of Ed. Data Processing, vol. 13, #13, p. 8.

Whereas RAM is usually volatile or power-dependent memory which can be erased and reprogrammed at will, ROM is permanently burned into the computer's memory boards, and hence is space unavailable to the programmer.<sup>7</sup>

Although microcomputer internal storage could

<sup>7</sup> Douglas and Edwards, op.cit., p. 64.

theoretically be all RAM, most machines employ a combination of RAM and ROM in their design. Current 8-bit microcomputers contain from 4000 to 64000 (4K to 64K) bytes of internal memory, a large percentage of which is RAM and therefore user accessible.

Data input for microcomputers could be accomplished by means of a number of external storage devices, but it is most commonly achieved via a keyboard which also controls computer operations.

Data output from microcomputers may be communicated to either a line printer, video screen, or external storage device.

Typical line printers accept data from the MPU and print characters on continuous rolls of paper by impact, heat, electrical charges, or spraying ink. The vast majority of microcomputers utilize impact printers due to the forbidding cost of sophisticated non-impact technology.

Video screens are common to most microcomputers, either as a built in feature or as an add-on component through which users may supply their own television.

External storage for microcomputers is commonly restricted to cassette tape or "floppy" disc, although hard discs are becoming more available as related technology improves.

Whereas earlier machines commonly employed cassette tape for external storage, this method has proved to be



inadequate due to both the serial\* nature and the inaccuracy involved. A much more efficient device is the 5¼" flexible (floppy) disc which stores more than 250,000 characters, and allows any point on its surface to be accessed in a fraction of a second. Newer approaches to this technology have produced an 8" disc capable of storing one million characters, and further advances in the area of increased transportable storage will soon be available.

Although the cost of the recently introduced hard disc units has been comparatively high, the benefits obtained in the form of storage capability, permanence, and access time may warrant their careful consideration. Permanent disc access time, while not available to the author, is known to be many times faster than that of floppy disc (approximately 0.5 seconds) and cassette tape (approximately 120 seconds).

Software for microcomputers, as with computers, consists of both the Operating (operating system and computer language(s)) and Application (programs) varieties.

Microcomputer operating systems are placed in ROM at the time of manufacture and facilitate using the attributes of the machine. Typical operating systems control input-output (I/O) functions (keyboard line printers, etc.) in addition to storage and retrieval of data.

The computer language most commonly used to communicate

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\* see page 11 of this paper for a discussion on serial access.

with microcomputers is BASIC. This language is not usually compiled, but is interpreted and executed one statement at a time in a very slow and tedious manner. With the development of an increasing number of microcomputers for business applications, interpreters will soon be completely replaced by compilers.

Application software refers to a program or series of instructions which the computer employs to solve a problem or to perform a specific task. As with larger computers, application software may be developed on-site or purchased (if available). Whatever the route, the importance of quality software cannot be overemphasized.

#### Differences Between Large Computers and Microcomputers

A comparison of large main-frame computers with smaller microcomputers is shown in Table I. It can be seen from Table I that, although similar in many respects, there are some major differences: differences with implications for administrative application in schools.

While the central processing units (CPU's or MPU's) of both types of computer perform similar functions, the large computer CPU is much more efficient and able to handle many jobs at once. This feature, when combined with a larger internal memory and expanded word size, produces significant differences in the ability of large computer and microcomputer central processing units. In particular, the smaller internal memory and 8-bit MPU common to a microcomputer severely restrict potential file manipulation

TABLE I

Comparison of Large Computers with Microcomputers

Basis for Comparison	Large Computer	Microcomputer
1. Central Processing Unit (CPU)	-usually LSI memory, but can be "chips" -capable of handling many jobs at once -very large amount of internal storage	-single-chip technology 8-bit MPU -can handle only one job at a time -capable of max. 64K internal storage
2. Data Input	-mostly punched card and keyboard	-mostly keyboard, some cassette tape/floppy disc
3. Data Output	-hard copy printer, video display, or tape/disc	-mostly hard copy printer (slow and expensive) -some video display, cassette tape, or floppy disc
4. External Storage	-tape or hard disc -large capability	-floppy disc or cassette tape (hard disc coming) -about 1000 records/8" floppy disc
5. Software	-available but very expensive -reliable	-little available, but cheap -mostly unproven
6. Cost	- \$100,000 plus	-approx. \$5000 and up
7. Speed	-computer itself very fast -card punching, waiting very time consuming	-relatively very slow
8. Repertoire	-unlimited possibilities	-difficulty with large data base and file manipulation

or data base operations of the type required for many administrative applications.

Although both machines may accept data input from a keyboard, larger computers typically have employed punched cards for this purpose. In terms of both the permanence of input data and the efficiency involved in repeated input operations, it would appear that the large computer possesses some advantage with its punched card input format.

Both the microcomputer and large computer are able to output data on video screen, line printer, tape, or disc. Therefore, any advantage that exists in this area would be due to the sophistication or speed of the related peripheral equipment attached to the different computers.

A large difference may be seen in the external storage common to these two computers. While the microcomputer employs cassette tape or floppy disc for this function, the larger computer attains much faster speed and increased capability through the use of wide tape or hard disc. Recent developments in hard disc technology have allowed some compatibility with microcomputers and may soon eliminate any incongruencies in this area.

Which type of computer has an advantage in the area of applications software is difficult to determine. While microcomputer software is unproven but cheap, large computer software is reliable but expensive. It would appear that whether one computer has an advantage in this area might depend upon the particular application and the expertise

or resources of the user.

From a cost viewpoint, the microcomputer is much less expensive than the larger main-frame computer.

When considering computer speed, it is necessary to examine the times required for both internal decision-making and peripheral operations. The larger computer has a clear advantage in both of these areas due to the sophistication of its hardware.

It would appear that the large main-frame computer possesses a number of advantages over the microcomputer. In fact, the only area in which the microcomputer leads relates to the cost of the units. However, it should be remembered that these two types of computer were developed to serve two entirely different groups of consumers.

The larger, main-frame computer, with its speed, size, and capability, was developed in response to needs of government and business. When confronted with hundred of thousands of drivers' licenses or social insurance numbers, the features common to these large computer systems are necessary.

The microcomputer, on the other hand, was intended to be a "personal" computer, not to rival or replace the large computer. In this respect, the microcomputer has been, and still is, a machine for managing personal and small business accounts, tutoring children, and playing sophisticated games. Efforts to extend its operation into the realm of the large main-frame computer have been rather extensive

but have produced limited results.<sup>8</sup>

### Administrative Functions of Microcomputers

Research Question #1 (Applications) was stated as follows:

"What administrative applications of the microcomputer are suggested in the literature by the authorities?"

In order to respond to this question, it is first necessary to discuss the related issues of functions of school administrators, computers and school administration, and microcomputers and school administration.

### Functions of School Administrators

The Seven Oaks School Division #10 Policy Statement regarding the Duties of Principals<sup>9</sup>, as presented in Appendix E, reveals that administrative duties are of two basic types: instructional leadership and organizational (school) maintenance.

From recent research in this area it can be seen that the largest percentage of an administrator's time is spent dealing with tasks in the organizational maintenance category. Boyd and Crowson, for instance, reported that high school principals studied spent ".... almost 80 per-

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<sup>8</sup> K. Billings, "Microcomputers in Education: Now and in the Future", MICROCOMPUTING, June 1980, p. 102.

<sup>9</sup> Seven Oaks School Division #10 Policy Manual, Section GBBAE, February, 1982.

cent of their time on organizational maintenance and pupil control tasks. By contrast, 17.4 percent of their time was spent on the school's academic program"<sup>10</sup>. Similarly, Peterson<sup>11</sup>, in his study of two elementary principals, found that neither administrator spent more than 6 percent of his time planning and coordinating the school program, curriculum, or materials.

While the bulk of their efforts would appear to be associated with organizational maintenance, many administrators are seeking to expand their instructional leadership function. A recent study by the Manitoba Teachers' Society on the changing roles of administrators found that: "... administrators would like to spend more time than they actually do on educational leadership-type activities such as curriculum, professional development, evaluation of professional staff, and community relations; and less time on clerical and teaching functions"<sup>12</sup>. Further support was reported by Willower and Fraser<sup>13</sup> in their study of school superintendents and principals where they found that both of these groups felt a need to be spending

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<sup>10</sup> W.L. Boyd and R.L. Crowson, "The Changing Conception and Practice of Public School Administration", Review of Research in Education, Vol. 9, 1981, p. 338.

<sup>11</sup> K. Peterson, "The Principal's Tasks", Administrator's Notebook, 1978, 26(8), p. 3.

<sup>12</sup> Manitoba Teachers' Society, "The Manitoba School Principal, Changing Roles and Responsibilities," March 1978, p. 20.

<sup>13</sup> D.J. Willower and H.W. Fraser, "School Superintendents and Their Work", Administrator's Notebook, 1980, 28(5), p. 4.

more time on, and in closer contact with, the instructional process in classrooms. Despite this apparent desire of administrators to reapportion their time, the M.T.S.<sup>14</sup> reports that recent rapid increases in job parameters have not been accompanied by compensating decreases in the remaining work load. Thus the dilemma of administrators with respect to time allocation appears likely to suffer further aggravation as their job description expands.

Marshall<sup>15</sup> contends that using the computer for administrative purposes in schools has the potential to address this administrative overload by decreasing the routine data manipulation tasks to be dealt with by administrators. In this way, administrators might be freed from a variety of clerical tasks and able to demonstrate a greater degree of instructional leadership.

The functions of the school administrator are diverse, yet it appears that far more of the principal's time is spent in routine information processing and gathering tasks than is desirable. It is in the context then, of the desirability of providing school administrators with the opportunity to engage in more educational leadership activities, that the next section examines the possible

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<sup>14</sup> Manitoba Teachers' Society, op.cit., p. 39.

<sup>15</sup> D.G. Marshall, "The Provision of Computerized Support for Manitoba Schools Faculty of Education, University of Manitoba, Winnipeg, Manitoba, 1982, p. 5.



application of computers to the administrative functions in schools.

### Computers and School Administration

Before examining the specific use of microcomputers in school administration, the general use of computers for administrative purposes will be discussed in order to provide information regarding the capabilities and limitations of microcomputers.

The computer can be of great value in reducing administrative time required for a number of tedious and repetitive tasks.

"Ample evidence abounds to support the application and acceptance of the computer when it is used for masses of data related to well-defined tasks, when processing is highly repetitive, when rules for decisions are specific, when processes are to be repeated many times under a variety of conditions, and where there is a great demand for speed "<sup>16</sup>.

Therefore, if computerization can be appropriately applied to educational data, it is reasonable to conclude that it can reduce the amount of professional time and energy previously devoted to clerical work.

From the literature (MECC<sup>17</sup>, University of Oregon<sup>18</sup>, and Sidman<sup>19</sup>) it appears that there do exist a number of school administrative functions suitable for general computer

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<sup>16</sup> University of Oregon, Dept. of Computer Science, "Computers in Education, Resource Handbook", 1973 p.VI.A.2.

<sup>17</sup> Minnesota Educational Computing Consortium, "A Feasibility Study of Administrative Uses of Microcomputers ", May, 1979, p. 5.

<sup>18</sup> University of Oregon, op.cit., p. VII.A.3.

<sup>19</sup> B. Sidman, Educational Computer Technology: A Manual/ Guide for Effective and Efficient Utilization by School Administrators, (Pao Alto, Calif: R & E Research Assoc.) p. 22, 1979.

use (see Table II). These functions applicable to an individual school are listed in Table II under five headings: finance, personnel, curriculum, students, and general. In all of the stated tasks the computer can play a significant role, either by assisting the school administrator in the task, or performing the task unassisted. It should be emphasized, however, that these tasks refer to computers in general, more specifically the larger main-frame computer and not the microcomputer.

Management systems. As schools have become larger and more diversified, and as it has become more expedient and necessary to develop tools for the management of the system, computers have been utilized by schools to facilitate planning, develop programs, and manage finances. As a result of this trend, a number of similar management systems have been designed (eg. PERT, RRPM, SPECS, PPBES, and PPBS) the last of which will be described herein. The PPBS (Planning-Programming-Budgeting System) is a major system analysis technique enabling school administrators to identify objectives, analyze alternatives, allocate resources over a period of time, and compare costs and effectiveness.

The first step in a PPB System is to state the objectives of the particular school system and the alternatives for the achievement of those objectives. The most feasible and promising approaches are determined and an analysis of program needs and resource allocations follow. Finally, evaluation reveals the extent to which the objectives have

TABLE II\*

ADMINISTRATIVE FUNCTIONS FOR GENERAL COMPUTER USE

A. Finance

1. General accounting (budget, receipts, expenditures)
2. Accounts payable/receivable
3. Financial Forecasting
4. Printout of detailed Financial reports for use by various levels of government
5. Detailed analysis of the overall budget
6. Accumulation of requisitions for quantity purchasing
7. Petty cash accounting
8. Continuous un-to-date inventory of all supplies and materials in the school
9. Analysis of materials and supplies for vendors
10. Generation of bills-debiting and crediting to proper accounts with immediate follow-up of unpaid bills
11. General ledger
12. Energy Management
13. Routing and delivery schedules for instructional and office supplies

B. Personnel

1. Staff personnel records - include certification, experience, qualifications, and in-service training
2. Staff evaluations
3. Scheduling teacher loads and class assignments
4. "Duty" lists

C. Curriculum - Registration and Scheduling

1. Course request records
2. Analysis of requests and proposed program
3. Check for course prerequisites
4. Special courses student list
5. Conflict schedules
6. Class schedules
7. Counsellor assignment lists
8. Master schedule preparation
9. Class lists for teachers
10. Room utilization and room assignment lists
11. Extracurricular activity assignments
12. Locks/lockers
13. Exam schedules
14. School calendar - schedule of work days, holidays, day cycle

D. Students (Census, Attendance, Progress)

Census

1. Enrollment projections and pre-school survey
2. Student directories
3. Mailing lists/labels
4. Graduate follow-up
5. Bus transportation - student lists, bus schedules
6. Guidance records
7. Students' cumulative files

Attendance Accounting

8. Daily attendance bulletins
9. Period by period attendance
10. Weekly, monthly, annual attendance
11. List of possible attendance problems
12. List of withdrawn and suspended students

Progress Reporting

13. Printing report cards
14. Honor roll selection and list
15. Student's marks list - year to date of courses taken and grade received
16. Pupil transcript
17. Grade analysis - by course and teacher
18. Identification of underachievers and overachievers
19. Statistical grade analysis
20. Test scoring and analysis
21. Athletic eligibility list

E. General

1. Library circulation
2. Film order lists
3. Media reservations (equipment, scheduling, inventory)
4. Project planning and budgeting
5. Word processing (newsletters, etc)

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\* Source: MECC (Feasibility Study, p. 5); University of Oregon (p. VII.A.3); and B. Sidman (p. 22)

been satisfied, and the process begins anew.

The specific process involved in PPBS or any other management system is not of concern here. What is important to point out is that: (1) the computer greatly facilitated the complex computations used in these systems, and (2) the computations are of such complexity that they require the extensive data manipulation potential found only on the large main-frame type computer.

Student data. Since the ultimate purpose and objective of good educational decisions must be related to the learner, it follows that student data forms the centre around which the remainder of the data and all administrative decisions should be based. The following are examples of some types of student data along with the kinds of information required, and possible product obtained in student record information processing.

(i) Census data consists of any facts regarding age, sex, grades, grade level, interests, test scores, attendance, health, and socio-economic background of a pupil. Data is normally transferred from an appropriate form to punched card or keyed directly into the computer. Such information, in abbreviated or coded form, comprises a student record which is stored alphabetically by surname on tape or disc.

Programs written to use this data are said to be "data base" and may address either simple or complex applications. While some simple or immediate products might include directories and mailing lists, it would be possible

for an administrator to use analysis and/or correlation of various items to produce more complex data such as enrollment projections, bus transportation lists, student interests by grade, sex, and age, as well as statistical information.

(ii) Attendance accounting provides the capability to collect and maintain information required for both daily and other periodic uses. Typical examples of this application normally involve secretarial staff in the process of transferring absentee data from standardized form or mark-sense card to the computer by means of keyboard or card reader.

Possible products to be obtained from this system range from a simple list of daily absentees to complex types of periodic attendance summaries which would require file manipulation and interpretation.

(iii) Pupil progress reporting allows for the collection of student performance scores and the updating of the student's record in the data file. Information is normally submitted by teachers using mark-sense cards or information forms and transferred to the computer by secretarial staff. A pupil grade or mark list for the course is immediately available, but various file operations are required to produce complex outputs such as report cards, student's mark list, course analysis, pupil transcript, and test scoring analysis.

Since all student data is personal and should be confidential, it is necessary for the school administration

and staff to assume responsibility for the security of student files, and thereby protect the rights of these students.

Since computer use for educational administration has been well documented for over 15 years, the list given is by no means complete. The number and types of applications will continue to increase as school administrators gain more sophistication in using systems concepts and computer technology to meet their existing and always increasing need for management data.<sup>20</sup> In this regard a major trend has been the development of total integration systems, capable of gathering information from any of the areas previously mentioned and, on request, presenting it in a meaningful report to the school administrator as background for decision making.<sup>21</sup>

Again, it should be re-emphasized that the above mentioned functions are potential applications, undelimited by a particular type of system. In the context of the purpose of this study, however, it is necessary to examine these functions with regard to the use of microcomputers for administrative purposes in schools.

#### Microcomputers and School Administration

Consideration of possible applications suggested by

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<sup>20</sup> Ibid, p. 25.

<sup>21</sup> University of Oregon, op.cit., p. VII.A.7.

MECC<sup>22</sup> and Richards<sup>23</sup> generates the listing of Potential Microcomputer Administrative Applications shown in Table III.

It should be made clear that the contents of Table III represent only a partial list of possible administrative applications of the microcomputer. In fact, if the rapid growth of the computer industry continues, we will soon see applications which reflect the impressive abilities of the new 256K microcomputers, rather than those restricted by the 48 or 64K machines common to most schools. Included in such a list will surely be a number of applications previously considered to have been in the domain of larger main-frame computers.<sup>24</sup> For the purposes of this study, however, the maximum memory is assumed to be 64K, which is common to microcomputers found in Winnipeg schools.

Restrictions due to nature of microcomputer. As could be expected from previous discussions in this paper, the nature of the microcomputer imposes some restrictions to its use in certain areas.

One such restricting factor is the extent of Random Access Memory (RAM) available to the user. Readers will

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<sup>22</sup> Minnesota Educational Computing Consortium, "Feasibility Study", op.cit., p. 7.

<sup>23</sup> D.M. Richards, "Micro-Processor and the Administration of the School", Challenge, Vol. XX, No. 2, 1980., p. 16.

<sup>24</sup> S. Bullock, "Computing in Manitoba", Education Manitoba, February 1981, p. 12.

TABLE III\*

Potential Microcomputer Administrative Applications

Student

1. Student Records (grades, lockers, courses, etc.)
2. Census (family)
3. Enrollment projection
4. Attendance (daily-building)
5. Attendance (annual)
6. Athletic eligibility list
7. Health records
8. Mark reporting and transcripts
9. Student scheduling assistance
10. Transportations (bus routes)
11. School calendar (schedule of work days, holidays, teacher days, 6-day cycle, etc.)
12. Guidance follow-up
13. Guidance records
14. Test scoring and analysis
15. Class lists

Personnel

1. Personnel record (certification, seniority, etc.)
2. Teaching assignments
3. "Duty" lists

Facilities

1. Facilities/equipment inventory
2. Energy management
3. Facilities Utilization
4. Maintenance (schedule of records)

Finance

1. General Accounting (budget, receipts, expenditures)
2. Accounts payable/receivable
3. Financial forecasting
4. Lunch programs (lunch counts, etc.)
5. Petty cash accounting
6. Vendor reports and purchase orders
7. General ledger

General

1. Library circulation
2. Film order lists
3. Media reservations (equipment, scheduling inventory)
4. Project planning and budgeting
5. Activity scheduling (extra-curricular)
6. Word processing (newsletters, etc.)
7. Mailing lists/labels (students, parents, staff, etc.)
8. Statistical analysis (research activities)
9. Ad hoc reporting from larger files

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\*Source: MECC (Feasibility Study), and D.M. Richards



recall that microcomputer internal memory is composed of both Random Access Memory (RAM) and Read Only Memory (ROM). Since approximately 25 percent of the microcomputer's RAM is used for arithmetic and logical operations (System Overhead), and since all of the ROM is used by the system the remaining memory available to the user is often considerably less than that specified by the manufacturer. The Apple II microcomputer, for example, lists 48K as maximum RAM but uses 10K for System Overhead, leaving only 38K available for the user.<sup>25</sup> Limitations in RAM can often result in increased processing time and decreased microcomputer efficiency due to the extensive use of external storage.

A further restriction on microcomputer capability occurs when large data base or file manipulation operations are involved. (A data base is a large and complex set of tables which describe some aspect of the world outside the computer. eg. library catalog, student record file, budget Most of these difficulties with data base and file manipulation stem from the inherent weaknesses in microcomputer hardware, operating systems, and computer languages. The Canadian Consumer<sup>26</sup> recently detected a number of such weaknesses in testing five brands of microcomputer common to the Canadian marketplace, and identified the related concerns found in

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<sup>25</sup> Minnesota Educational Computing Consortium, "Microcomputer Report ", July 1979, p. 9.

<sup>26</sup> Canadian Consumer, "Computer Consciousness ", April 1982, p. 11.

Table IV.

Further limitations may be placed on microcomputer use due to the time required to perform complex tasks. For example, given a file of 1200 records, it would require approximately 30 minutes of computer time to alphabetize the list of students using the Apple II system with double disc drives.<sup>27</sup> Similar difficulties with time consumption were documented by Richards<sup>28</sup> who experienced a multitude of hardware malfunctions while attempting to generate student progress reports.

Location, size, and personnel can be additional restricting factors. For example, a rural school may be more inclined to use the microcomputer for administrative functions unavailable to them through urban based data system services. Similarly, schools possessing large microcomputers and computer literate staff will be more capable of extensive administrative applications.

While a number of restrictions may exist due to the nature of the microcomputer or the particular situation in which it is being applied, many possibilities still remain for its use in school administration.

Most feasible administrative applications. For the purposes of this paper, "feasible" shall be defined as "capable of being done". In this context, the purpose of this

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<sup>27</sup> MECC, "Feasibility Study", op.cit., p. 10.

<sup>28</sup> D.M. Richards, op. cit., p. 16.

TABLE IV\*

Canadian Consumer Concerns Re: Microcomputers

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1. Variables and strings - "Variables" represent numbers stored in memory; "strings" represent groups of letters. Some micros are limited in the total number of variables or strings; others limited the length of strings. "Arrays" are convenient ways of collecting variables or strings into groups; some limited the size of arrays and some did not permit arrays of strings.
2. Integer Range - The range of whole numbers the computer can handle. Some were limited to a maximum of 32767 (or -32767).
3. Floating Point Range and Accuracy - Floating Point arithmetic allows you to have a decimal point. Some computers allowed only 6 digit precision, others allowed nine, and some allowed double precision accuracy.
4. Formatted Output - Ideally, the computer should let you specify the number of digits to be printed (two after the decimal point for money, for example), and the way the data is to be arranged in a column - with all the decimal points aligned, for example. Formatted output was not very common.
5. Storing Programs and Data - All models tested could permanently store on cassette and most would allow you to store under a name. The guidance on storing data and reading stored data was hard to find and difficult to follow.

NOTE: Models tested were the Apple II Plus, Commodore PET 4016N, Rockwell Aim 65-415, Sharp PC-1211, and Sinclair ZX-81.

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\*Source: Canadian Consumer, April 1982, p.11

section is to describe those administrative applications which are the most capable of being done using a micro-computer. While a variety of factors might contribute to the perceived feasibility of any application, MECC<sup>29</sup> identified the three most important components to be ease of implementation, expected interest, and need, and used them to arrive at this list of ten applications of greatest feasibility (not in priority order):

- daily attendance
- facilities/equipment inventory
- lunch program accounting
- student scheduling assistance
- student record management
- instructional management (teaching assignments, duties)
- accounts payable, general ledger
- media accounting, scheduling management
- test scoring
- ad hoc reporting from larger data files

It should be emphasized that this suggested list of most feasible applications represents the survey results obtained by MECC from selected users in their state of Minnesota, and by no means precludes the possibility that other applications could be judged most feasible elsewhere. However, three important features common to this and any list of most feasible applications are: (1) the list is limited in length; (2) the applications are for a tedious or repetitive task, and (3) the applications reflect the limited ability of the microcomputer (eg. student scheduling assistance, not total student scheduling).

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<sup>29</sup> MECC, "Feasibility Study", op. cit. p. 11

Conclusion: Research Question #1 (Applications)

The extent to which microcomputers can be used administratively is yet to be determined. While it is true that microcomputers are capable of performing approximately 80% of the required administrative tasks, problems do arise with large data base or file manipulation operations due to limited internal storage and other hardware considerations.<sup>30</sup> One example of such a limitation is in the area of student scheduling where the microcomputer is capable of generating only a conflict matrix of questionable application benefit.

It is clear that the microcomputer can be very effective when used for a large number of items and a tedious or repetitive task of such a nature that the machine is tabulating, computing, retrieving, or storing, with the major decision making power remaining with the operator.

Some uses of this type which are also considered to be most feasible applications include daily attendance, inventory, accounts payable, general ledger, and student record management.

Software

As previously noted, computer software is of two types:

- (1) Operating Software (language and operating system), and Application Software (programs).

Research Question #3 (Software) was stated as follows:

- (a) "What operating and application software is avail-

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<sup>30</sup> Ibid, p. 9.

able, and which of these are recommended by the literature?"

(b) "What sources of software exist for the prospective user in Manitoba?"

### Operating Software

Operating system. Most brands of microcomputer available today are 8-bit machines employing the CP/M operating system. While this particular operating system is not known for its high levels of efficiency, its continued use in many machines can be explained, at least in part, by the desirability to inter-communicate between microcomputers with like systems.<sup>31</sup> This trend may be altered somewhat by the introduction of the Turbodos system which allows operating systems of different types to inter-communicate.<sup>32</sup>

Present operating software available on 8-bit machines, while not ideal in that it has some limitations, generally functions dependably for many years.

Since the 8-bit machines are somewhat limited in memory (effective 64K), operating system, and speed (one job at a time), it is not surprising that they are soon to be replaced by 16-bit microcomputers. These new generation machines will possess internal memory of 256K, standardized sophisticated UNIX operating systems, and the ability to process many jobs simultaneously.<sup>33</sup> In addition, they are

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<sup>31</sup> Statement by G. Evans, Dataoptics Ltd., in a personal interview, Winnipeg, Man., April 8, 1982.

<sup>32</sup> Ibid.      <sup>33</sup> Ibid.

expected to be competitive in price to their 8-bit predecessors. Further advances in microtechnology and mass production methods are expected to produce 32-bit microcomputers to rival the 16-bit machines within the next few years.<sup>34</sup>

Computer language software. The computer language software existing on common microcomputers consists of some version of the BASIC language which may support a number of other languages (PASCAL, FORTRAN, etc.).

A microcomputer should have a version of BASIC which meets or exceeds the mandatory criteria shown in Table V.<sup>35</sup>

While it is recognized that the information contained in Table V may be too complex for the average reader, it is presented here to demonstrate that such guidelines do exist and are available to prospective microcomputer purchasers and/or their agents.

Conclusion: Research Question #3 (a) (Software):

At this time, most brands of microcomputers are 8-bit machines, many of which employ the CP/M operating system. Inter-communication between machines with different operating systems can often be achieved by employing a Turbodos link.

Experts predict that within a short time the 16-bit microcomputers will replace the 8-bit machines and thus

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<sup>34</sup> Ibid.

<sup>35</sup> MECC, "Microcomputer Report", op. cit., p. 77.

TABLE V\*

Mandatory/Desirable Basic Language Features

Mandatory

1. Syntax errors must be given by specifying the line or the place in the line.
2. Execution errors must be given by code number or text description.
3. Full set of relational (<, <=, >, >=, < >) and logical (and, or, not) operators.
4. Standard string functions LEN, SUBSTR, VAL, STR, ASC, CHR, or equivalent.
5. Five column print or packed print convention using ", " or ";".
6. Mathematical functions ABS, EXP, INT, RND, SQR, SIN, COS, ATN.
7. Arrays must be at least 2 dimensions.
8. FOR/NEXT loops must allow nesting.
9. READ/WRITE to external sequential files must be possible.
10. Number of string variables must be at least 26.
11. Length of stored strings must be at least 60 characters.
12. Conforms to BASIC syntax conventions (similar to CDC BASIC 3.1 or Dartmouth BASIC).
13. Allows multiple character variable names.
14. Performs floating-point arithmetic.

Desirable

1. Number of string variables allowed be greater than 26.
2. Additional mathematical functions MAX, MIN, ASN, ACS, SGN, TAN, LOG, LGT.
3. Length of stored strings be greater than 80.
4. String arrays be allowed.
5. Formatted output be allowed.
6. Matrix arithmetic operations be allowed.
7. Matrix I/O be allowed.
8. GO SUBS be permitted to be nested.
9. READ/WRITE to random access files be allowed.
10. Timed input, CLK, and PLOT (x,y) functions be supported.

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\* Source: MECC (Microcomputer Report), op. cit. p. 77.



greatly expand microcomputer capability.<sup>36</sup>

While all common microcomputers support some version of the BASIC language, variations in capability of the different levels of BASIC are extreme. Since a weaker language can drastically reduce the scope of applications, users should ensure that the level of BASIC purchased incorporates many of the features given in Table V.

### Application Software

Those wishing to use the microcomputer for administration would appear to have three choices with respect to application software or programs: (1) develop their own software; (2) purchase existing software; or (3) have existing software modified or new software developed to desired specifications.

The development of software by local personnel is often a demanding, time-consuming, and inefficient route. This path to software development is contingent upon: (1) the existence of someone at the local level who possesses the necessary programming expertise, and (2) the willingness of the individual and/or the system to commit sufficient time for software development. Although both of these conditions may exist, users should be advised that further problems have sometimes arisen due to the quality and documentation of programs developed in this manner. Local initiative has, however, been instrumental in some schools

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<sup>36</sup> G. Evans, loc. cit.



in developing limited administrative software.

Those wishing to purchase software soon discover that very little has been produced in the area of educational administration. Since the main thrusts of manufacturers and publishers have been in the areas of computer assisted instruction and home entertainment, a limited number of administrative applications have been developed. Though this void is slowly being addressed by suppliers, users in the field are generally not impressed with the quality of software being produced, and do not recommend the purchase of such programs at this time.<sup>37</sup> It would seem that if and when the demand for administrative programs is such that software houses and publishers are assured of a market for their products, then the desired administrative software will become available.<sup>38</sup>

The third alternative, having existing software modified or new software developed to suit the user's needs, deserves careful consideration. While the modification of existing software may be possible, this process has experienced limited success in the field. MECC, for example, attempted to modify a commercially available mailing list/label program to run on the Apple II microcomputer.<sup>39</sup> The project encountered many obstacles, and was unsuccessful due to the limited capability of the business software.<sup>40</sup>

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<sup>37</sup>MECC, "Feasibility Study", op.cit., p.B-1.

<sup>38</sup>K.Billings, op.cit., p.102.

<sup>39</sup>MECC, "Feasibility Study", loc.cit.

<sup>40</sup>Ibid.

In general, business/education conversions or adaptations are not being recommended by users.

A far more tenable approach would seem to be the development of new software, specific to a school's needs, by a software firm. It has been estimated that the most sophisticated data base management program required by a school could be developed for less than \$3000.<sup>41</sup> In this case the developer is modifying a number of existing programs and tailoring them to the individual needs of a particular school or school division. Since most developers would have had long experience in the data management field, it could be expected that the software produced by this method would be of a high quality.

Users are advised that, whatever the choice, software is generally compatible with only certain hardware and operating software. For example, a TRS-80 Model I program cannot be used on a TRS-80 Model II system without some modifications. Similarly, programs written for the Apple II system with Integer BASIC will not function properly on an Apple system using Applesoft BASIC. Numerous additional complications may arise because of hardware variations from system to system (eg: printers of various widths, carriage control differences, incompatibility of disc drives, etc.) As a general guideline, software purchasers should ensure

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<sup>41</sup> T. Smythe, Mycroft Business Machines, Canada, "Administrative Potential of Microcomputers", (Address to Administrative Users' Group, Winnipeg, Man.) Dec. 1981.

that programs are: (1) compatible with the microcomputer hardware that they will be using, and (2) possessing high levels of efficiency, reliability, flexibility, and documentation.<sup>42</sup>

Conclusion: Research Question #3 (b) (Software)

At this time, only a small amount of administrative software is commercially available, and most of it has not been proven in a field testing situation. Therefore, it appears that the best route to administrative software is for schools to either develop their own or to contract its development to suit their specific needs. Which of these alternatives a school might choose would depend on a variety of factors such as local expertise, initiative, time, needs and finances.

Hardware

Research Question #5 (Hardware) was stated as follows:

"What are the options in microcomputer hardware available for administrative use in schools, and which of these are recommended in the literature?"

Findings

General consensus exists in the literature that the particular make of microcomputer is not necessarily critical, so long as it is one of the more popular

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<sup>42</sup> D. G. Marshall, "Purchasing a Microprocessor System For Administrative Use in Schools", (Address given to Manitoba Association of School Superintendents, Brandon, Man.) Feb., 1982.

brands.<sup>43</sup> There are differences between microcomputers just as there are between automobiles, but each of the popular makes can be expected to give years of dependable service.

While some writers recommend that computer (internal) memory should be at least 32K,<sup>44</sup> for successful administrative applications it is preferable that this memory be the maximum possible on the particular model of microcomputer.<sup>45</sup> Readers are reminded that a portion of the stated internal memory of a machine is consumed in storing the operating system and computer languages. Therefore, it is recommended that prospective purchasers ascertain what memory remains available to the user, rather than the total memory size of the microcomputer.<sup>46</sup>

Some examples of various microcomputer administrative capabilities are given in Table VI.<sup>47</sup> Careful examination of this table reveals, as might be expected, that the number and extent of administrative applications possible vary with the sophistication of the microcomputer system.

External or mass storage devices available for use with various microcomputers include cassette tape, floppy disc, hard disc, and cartridge drives (eg. Winchester and Megabyte). Most users will find two floppy discs to be

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<sup>43</sup> G. Ropes and H. Gaylord, "Bringing Microcomputers Into Schools", Microcomputing, June 1980, P. 104.

<sup>44</sup> MECC, "Feasibility Study", op.cit., p. 2.

<sup>45</sup> D.M. Richards, op.cit., p.15. <sup>46</sup> MECC, Microcomputer Report, op.cit., p. 9.

<sup>47</sup> D.M. Richards, op.cit., p. 17.

TABLE VI

Examples of Microcomputer Administrative Capabilities

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16K microcomputer, cassette drive, black and white monitor	capable of performing calculations of a statistical nature
48 K microcomputer, cassette drive, black and white monitor	capable of some operations research calculations, elementary simulations
48 K microcomputer, cassette drive, black and white monitor, basic printer	capabilities as above but with hard copy
48K microcomputer, cassette drive, diskette drive, black and white monitor, basic printer	capable of student reports class lists, etc. at a slow speed and low quality print
48K microcomputer, cassette drive, diskette drive, black and white monitor, report quality printer	capable of student reports, class lists, etc. at a slow speed, but in good quality print
48K microcomputer, cassette drive, diskette drive, hard disc drive, black and white monitor, report quality printer	capable of student reports, class lists, manipulation of timetable at reasonable speed and in good quality print

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Note: 1980 prices have been removed.

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Source: D.M. Richards, "Micro Processors and the Administration of the School", Challenge, Vol. XX, No. 2, 1981, p. 17.

adequate for administrative applications, although hard disc units would be of definite benefit due to their increased accuracy and lower response times. At the present time, hard disc units have only recently been introduced and remain relatively expensive and untested.<sup>48</sup>

Those users seriously considering administrative applications will find a good quality line printer to be a necessity. A great variety of printers is available with prices varying according to printing method, speed, and quality of output. As documented by Richards<sup>49</sup>, a slow printer of poor quality can waste an enormous amount of time. Therefore, users are advised not to economize in this area, but rather to purchase good quality line printers capable of 30 to 120 characters per second.<sup>50</sup>

Three different types of video screen are currently in use on microcomputers: black and white, green and black (phosphor), and color. Whereas some microcomputers feature built-in video screens and others lack color capability, still others leave the choice to the user. Color video capability is largely a matter of individual preference, although programs involving designs and patterns may be significantly enhanced with the color feature.<sup>51</sup> Purchasers choosing options other than the black and white should be aware that operators using such monitors for several

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<sup>48</sup> Ibid, p. 15.      <sup>49</sup> Ibid, p. 17.

<sup>50</sup> MECC, "Feasibility Study", op.cit., p. 10.

<sup>51</sup> G. Ropes and H. Gaylord, op. cit., p. 104.

consecutive hours have often complained of eye fatigue and tension.<sup>52</sup>

While the fear of obsolescence may be common to many microcomputer buyers, Ropes and Gaylord<sup>53</sup> suggest that this notion should be quickly dispelled. Although it may be true that tomorrow's advances in microcomputer technology could make today's microcomputer appear less glamorous from an electronics standpoint and technically obsolete, if the machine still performs the tasks required by the user, then it is not functionally obsolete. In this context, obsolescence is only a state of mind.

Another misconception appears to exist concerning potential price reduction by microcomputer manufacturers. The contention or expectation that prices of microcomputers will drastically decrease would seem to be remote.<sup>54</sup> Unlike calculator prices which plunged rapidly, microcomputer prices are expected to remain constant, due in part to the increasing capabilities of the newer models.

Conclusion: Research Question #5 (Hardware).

A microcomputer should be one of the more common makes and possess a minimum internal memory of 32K. External storage by floppy disc unit is recommended by the literature,

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<sup>52</sup> Statement by D. Trainor, Vincent Massey Collegiate, in a personal interview, Winnipeg, Manitoba, May 28, 1981.

<sup>53</sup> G. Ropes and H. Gaylord, op. cit., p. 105.

<sup>54</sup> Ibid, p. 104.



but prospective purchasers are advised that such options can be added at a later date. In addition, users in the field (MECC) give high priority to a good quality line printer capable of 30 - 120 characters per second.<sup>55</sup>

Whatever the choice, the microcomputer purchased by a school today should allow for expansion to meet the user's needs of tomorrow. For administrative purposes, this may mean the consideration of a 16-bit machine.

### Costs

This section examines the costs of computer use for educational administration in the following three areas:

(1) time; (2) resources; and (3) personnel.

Research question #7 (Costs) was stated as follows:

"What is the cost in time, resources, and personnel to those schools using computer based administrative services?"

### Findings

Time. Efficiency, in terms of input of time and money compared to final product outcome, is one of the most important facets of successful administration. As our society becomes more "time" oriented, principals and other educational administrators are seeking methods of releasing teachers and themselves from clerical and routine work, and are thereby hoping to improve on the efficiency of the system.<sup>56</sup> Since computer use may be a means of accomplishing

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<sup>55</sup> MECC, "Feasibility Study", op.cit, p. 10.

<sup>56</sup> University of Oregon, op.cit., p. VI.A.2.

this goal, it is important to discuss the time costs for a school wishing to implement microcomputer administrative applications.

Initially, school officials would be required to expend varied amounts of time in order to prepare themselves and their school for computerized administrative applications.<sup>57</sup> It could be expected that one or more staff would be responsible for researching current microcomputer uses, testing the market, writing computer use proposals, and recommending the purchase of a current model from the existing marketplace. Following the installation of the system, start-up difficulties and technical problems often occur and can be very time-consuming.<sup>58</sup>

Due to the varying conditions in which schools and administrators find themselves, it is difficult to estimate the time required for the execution of these preparatory steps. However, it is clear that substantial efforts may be required to successfully initiate microcomputer operations in a school.<sup>59</sup>

The required application software (programs), if not commercially available or custom made, must be written by available school personnel. While no predetermined number of hours will produce a specific program; it has been

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<sup>57</sup> P.P. McGraw, "The Computer and the Educational Administrator", Computer Concepts and Educational Administration, ed. Robert Marker (Los Angeles: U.C.L.A., 1966), p. 7.

<sup>58</sup> D.M. Richards, op.cit., p. 17.

<sup>59</sup> G. Ropes and H. Gaylord, op.cit., p. 105.

conservatively estimated that a programmer must work from 100 - 300 hours to produce 1 hour of programming in the instructional area.<sup>60</sup> It would appear that considerable commitment could be required to develop suitable administrative software, and that this fact should be carefully considered by those intending to use local expertise for this purpose.<sup>61</sup>

Another time concern centers around the nature of the microcomputer itself. Since machines are, of course, only machines, they can fail or malfunction at the most inopportune moments, often creating considerable stress and lack of productivity in the process. Even though these problems might be reduced by preventative maintenance, their total elimination is not to be expected. Hence, schools choosing to computerize administrative functions can anticipate at least some degree of technical difficulty.<sup>62</sup>

A final consideration in the discussion of time is the period actually required by the microcomputer to perform the required calculations and produce hard copy output. Two typical case studies are reported in the literature and serve to illustrate this point.

One study was conducted by MECC<sup>63</sup> in 1979 using a

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<sup>60</sup> D.G. Marshall, "School Administrator and the Microcomputer ", op.cit., p. 13.

<sup>61</sup> D.M. Richards, op.cit., p. 15. <sup>62</sup> Ibid, p. 18.

<sup>63</sup> MECC, "Feasibility Study", op.cit., p. 9.

32K Apple II with dual disc drives and a line printer capable of 30 - 120 characters per second.

- Information on the microcomputer file was grouped by records. A record may be data about a particular student, piece of equipment, etc..
- Most records are about 80 columns wide.
- Twelve hundred of the 80 column records can be stored on an Apple II diskette. If those 1200 records were on the diskette, then the following times would apply:
  - To enquire about any student by identification number require 1 to 3 seconds of time.
  - To enquire about any student whose identification number is not known would require about 6 minutes of time.
  - To find all the students who have missed more than 6 days of school would require about 6 minutes plus the time required to print the list.
  - To alphabetize the list of 1200 students would require about 30 minutes.

Another study was conducted by Richards<sup>64</sup> using a 48K Sorcerer with dual disc drives and an Anderson-Jacobson daisy-wheel printer.

- Programs being used were part of the Selector III (Micro-Ap) Information Management System.
- 353 records similar to student records in a school were entered.
- Student progress reports were expected to be produced using about 18 hours of machine time.
- The microcomputer had to be restarted more than 30 times during the run.
- The printer had two new ribbons, four adjustments, and several other repairs during the run.
- The job took three days to complete.
- A later test of the microcomputer revealed three separate locations where the memory was faulty.

While the introduction of new systems with more efficient programs will probably reduce the time somewhat, it appears that some operations currently require far too

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<sup>64</sup> D.G. Richards, op.cit., p. 16.

long to be considered efficient.

Resources. Today's administrator faces growing public pressure to obtain the best educational system for the least amount of money. Confronted by such public concern for increased accountability, the administrator must be well prepared to justify computer expenditures.

Those schools planning to use the microcomputer for administration should be aware that substantial resources will be required for this project, both initially and over the long term. As an initial expense, users should purchase a microcomputer which will allow for expansion as a school realizes and eventually outgrows its potential.<sup>65</sup> While microcomputers of very limited ability may be available for several hundred dollars<sup>66</sup>, a typical microcomputer system suitable for administrative use could be expected to cost at least \$5,000 as an initial expenditure. Potential users can anticipate further funding requirements for maintenance, supplies, and expansion during the period of computer use in the school.<sup>67</sup>

Administrators contemplating microcomputer use for administration are advised to carefully consider the sources of required software before purchasing hardware. If the intention is to have the software custom made, then the

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<sup>65</sup> P. Stark, "Student Scheduling on a Small Computer", Microcomputing, June 1980, p. 117.

<sup>66</sup> Canadian Consumer, op.cit., p. 12.

<sup>67</sup> D.M. Richards, op.cit., p. 16.

results of a study by G. Jersak<sup>68</sup> may be valuable.

Mr. Jersak, as a member of the Educational Administrators' User Group and principal of Dakota Collegiate, wrote to Winnipeg companies requesting proposals to supply the hardware/software requirements for his school. Given a typical high school of 800 students and 50 teachers, companies were asked to submit proposals for the provision of the following services:

- Retrieval of up-to-date lists by age, sex, class, feeder school, medical problems, locker, library fines, student's fees, etc..
- Grade reporting including report print-out, course average, running commentary, cumulation of credits.
- Student cumulative records by course and grade from the previous year.
- Student scheduling: conflict matrix with ability to add or change, free rooms, course tally, student timetable, school master timetable, teacher schedules, room schedules.
- Word processing potential.

Responses received are summarized without reference to company name in Table VII.<sup>69</sup>

Whether potential purchasers are considering only hardware or a hardware/software package, it is probable that many schools would experience difficulty in attempting to extract the required funds from already stretched budgets. In this regard, various avenues may be available to achieve the necessary financial support and establish administrative

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<sup>68</sup> G. Jersak, "Requests for Proposal to Microcomputer Software/Hardware Vendors", Winnipeg, Manitoba, January, 1982.

<sup>69</sup> Ibid.

TABLE VII\*

Responses to Request for Proposal

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- Response #1 - Independent study to be done before proceeding further.
- Response #2 - No estimate on software. Recommend for hardware either micro with 5¼" diskette (\$12,000) or with 8" diskette (\$20,000 to \$28,000)
- Response #3 - Initial design and development/installation costs of \$4700. Hardware to consist of Service Bureau Computer connected by phone terminals and printers at school site. Required hardware can either be rented at \$1800 per year or bought at \$2900. In either case, costs of computer use and telephone will still be about \$3000 per year.
- Response #4 - Software costs of \$2500, and study costs of \$4000. Hardware to cost \$17,000 and to include a 64K microcomputer with hard disc and letter quality printer.
- Response #5 - Many of the software requirements available for the PET micro can be used to build a package, cost - \$2500. A minicomputer is recommended for scheduling.
- Response #6 - Full range of software available for many micro-computer systems. Cost of software for Commodore system is \$6500 with rights to distribute, or \$550 per school if for school's own use.
- Response #7 - Package price of \$15,000 which includes software, Commodore 8032 micro, disc drive, letter quality printer, and extended warranty at extra \$150/mo.
- Response #8 - Software packages available at \$10 to \$300 per package. Hardware to be purchased from them as required with personnel training courses available.
- Response #9 - Software is supplied for \$3000 initially, and \$600 per year afterwards. User buys specified Apple II hardware which must meet specifications and include monitor screen, printer and optical reader.
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\* Source: G. Jersak, "Requests for Proposal to Microcomputer Software/Hardware Vendors", Winnipeg, Man., Jan., 1982.

microcomputer applications in a school.<sup>70</sup> While some boards of education have allocated funds for microcomputers directly in their budgets, parent-teacher associations have also demonstrated their willingness to allocate money for microcomputer purchase(s). In attempting to overcome funding difficulties, many groups have found it useful to compare the cost-effectiveness of a microcomputer with that of a color television, videotape machine, or one of the division's service vehicles.<sup>71</sup>

Personnel. The introduction of a microcomputer for administrative use is almost certain to have some consequences for school staff. While this area is not well documented in current research, some probable impact points have been suggested.

Marshall<sup>72</sup> contends that an administrative microcomputer system and the resulting need for someone to develop and maintain administrative programs can place pressure on existing school personnel and influence staffing patterns. Although additional staff may be employed to solve this problem during the developmental stage, experience has shown that these staff are not sustained through the long term.<sup>73</sup> Consequently, the responsibility for administrative and other functions of the microcomputer remains with the

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<sup>70</sup> G. Ropes and H. Gaylord, loc.cit.

<sup>71</sup> Ibid.

<sup>72</sup> D.G. Marshall, "Purchasing a Microcomputer System", op.cit., p. 15.

<sup>73</sup> University of Oregon, op.cit., p. VI.A.2.



administrator.

Unfortunately, since the majority of administrative personnel are woefully unprepared in the area of computer technology, their decisions regarding microcomputer use in their schools are unreliable.<sup>74</sup> If computers are to be seriously considered for educational applications, effort must be made to prepare people in this line of work who have also had experience in the classroom and in school management. The modern school administrator need not be an expert in the field of computers for educational purposes, but it is highly desirable that he be more than a novice. This is not to say that we cannot learn from others, but rather that educators are those who have the responsibility for decisions regarding education.<sup>75</sup>

Conclusion: Research Question #7 (Costs)

The consideration of time, resource, and personnel costs are critical to any initiatives involving the computer for administrative use.

Time consumption is an important factor for those intending to introduce administrative functions on a microcomputer. Many hours will be spent on a variety of preparatory steps ranging from researching the marketplace to solving minor installation problems.<sup>76</sup> Further time costs can be expected in the development or adaptation of

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<sup>74</sup> Ibid.      <sup>75</sup> Ibid.

<sup>76</sup> G. Ropes and H. Gaylord, op.cit., p. 105.

suitable administrative software<sup>77</sup>, where 100-300 hours may be required to produce 1 hour of actual programming.<sup>78</sup>

A final consideration in the discussion of time is the considerable period that is often required by the micro-computer in order to produce the desired output.<sup>79, 80</sup>

Although the introduction of new systems may improve these times, it would appear that some administrative functions require a great deal of microcomputer and user time before generating output.

Those intending to use a microcomputer for administration are advised that an initial hardware expenditure of approximately \$5000 will be required, and that further hardware upkeep costs can be expected. Software costs could be up to \$3000<sup>81</sup> or more depending on the method chosen and the particular circumstances of a given school. In any case, a total initial expenditure of \$10,000 is quite possible.

Personnel costs are not as precisely defined in the literature. While there would probably be some effect on all school staff, it is the role of the school administrator that

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<sup>77</sup> D.M. Richards, op.cit., p. 15.

<sup>78</sup> D.G. Marshall, "School Administrator and the Microcomputer ", op.cit., p. 13.

<sup>79</sup> D.M. Richards, op.cit., p. 16.

<sup>80</sup> MECC, "Feasibility Study", op.cit., p. 9.

<sup>81</sup> T. Smythe, loc.cit.

is likely to experience the greatest change. Since most administrators are unprepared in the area of computer technology, their decisions regarding microcomputer use in their schools will be based on fragmented knowledge.<sup>82</sup> The challenge is to create administrators who have knowledge in computer technology, as well as experience in the classroom and school management.<sup>83</sup>

#### Administrative Roles

In this section of the chapter, areas identified by Marshall<sup>84</sup> will be used as a framework to identify possible effects of the microcomputer on the role of the principal.

Research question #9 (Administrative Roles) was stated as follows:

"What implications will the advent of the microcomputer have upon the role of educational administrators?"

#### Findings.

It is clear that the microcomputer is already affecting and will continue to affect the practice of educational administration. Although some latitude may exist as to when and how it will enter a particular school, the certainty that the microcomputer will appear is irrefutable.

Marshall<sup>85</sup> identifies four major areas of concern for

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<sup>82</sup> University of Oregon, op.cit., p. VI.A.2. <sup>83</sup> Ibid.

<sup>84</sup> D.G. Marshall, "School Administrator and the Microcomputer", op.cit., p. 4.

<sup>85</sup> Ibid.

the school administrator in the context of the "micro" revolution: (1) decision making; (2) management concerns; (3) instructional concerns; and (4) societal concerns.

Decision making. While many theories of decision making abound, all of them acknowledge the importance of accurate information to the basic decision making process. The microcomputer, in supplying larger quantities of accurate information, has created a perplexing state of "information overload" for the administrator/decision maker.<sup>86</sup>

This increased volume of information available to the administrator will demand the development of new skills for selecting and interpreting data appropriate to their specific needs. Since reams of paper littered with irrelevant information often confuse the issue being considered, it is most important that administrators possess the skills to formulate the correct questions so as to receive the best possible answers.

As the microcomputer makes its way through home and offices, the public will become more aware of the wide range of information available to the administrator. Accordingly, they will expect administrative decisions to reflect high levels of rational thinking, and not simply be based upon previous habits or personal values of the decision maker.

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<sup>86</sup> R.J. Dennis, "The School Administrator's Introduction to Computing", (Illinois Series on Educational Application of Computers, No. 161, Illinois University, Urbana Dept. of Secondary Education, 1979), pp. 4 - 7.

Consequently, school officials will no longer be able to plead "insufficient information", but will be held accountable for all decisions, whether big or small.

Compounding the pressures on administrators will be a shift towards decentralized decision making. Since data which formerly could be processed only by large mainframe computers will now be available on microcomputers, it is logical that information processing will tend to be decentralized back to the individual school. This shift in power could create decision making power beyond the experience of many of today's administrators.

Management concerns. Marshall<sup>87</sup> projects that as the general public becomes aware of the potential of microcomputers for educational administration they will expect the administrator to be freed from many time consuming trivia. Accordingly, the administrator will be expected to spend less time on office duties and more time in the total environment of the school. For some administrators this implies a change in management priorities and style.

The role of the school administrator will experience further change as he begins to manage microcomputer operations in his school. Many decisions must be made regarding microcomputer selection, purchase, security, and applications, and the school administrator must be a knowledgeable

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<sup>87</sup> D.G. Marshall, "School Administrator and the Microcomputer ", op.cit., p. 6.

microcomputer consumer in order to properly respond. While it is not imperative that he be an expert, it is certain that he should not be a novice.<sup>88</sup>

Instructional concerns. As the age of the microcomputer develops, it can be expected that Computer Assisted Instruction (CAI) will no longer be considered an innovation, but rather an integral part of the instructional process in many schools. The school administrator, in his role as instructional leader, will be responsible for the implementation and control of CAI in curricula. Therefore, it is imperative that the school administrator be computer literate.

More specifically, administrators must be knowledgeable in the area of microcomputer software. Much of the available instructional software is of poor quality and without sufficient documentation.<sup>89</sup> As a result, schools are being forced to produce their own software which is compatible with their own needs and hardware. In his role as instructional leader, the school administrator must be prepared and qualified to evaluate available software and/or to provide a local environment for software production.

Societal concerns. Since adapting and reacting to changing community needs and concerns is an important function of any school administrator, it follows that the

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<sup>88</sup> University of Oregon, op.cit., p. VI.A.14.

<sup>89</sup> R.W. Steele, "Evaluating Small Systems Applications Software", Microcomputing, June 1980, p. 169.

age of the microcomputer may have created some new problems in this area. It is difficult to speculate on the feelings of teachers or of the general public towards computer use in education, but it is most important that the school administrator be sensitive to needs of these groups.<sup>90</sup>

Even while giving proper consideration to those societal attitudes and concerns, the administrator must continue to respond to issues of fundamental computer literacy. "It has been suggested that the ignorance of computers will render people as functionally illiterate as ignorance of reading and writing and arithmetic"<sup>91</sup>. In this context it is crucial that school administrators address computer literacy programs in a realistic and productive manner.

Conclusion: Research Question #9 (Administrative Roles)

The role of the educational administrator must adjust to the advent of the microcomputer. While the administrator of yesterday might have had a choice in allowing the computer into his school, the administrator of today does not. What may possibly be controlled by today's administrator is the extent of microcomputer use for various instructional and administrative applications. To be successful in these

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<sup>90</sup> D.G. Marshall, "School Administrators and the Microcomputer op.cit., p. 15.

<sup>91</sup> Ibid, p. 16.

areas, the school administrator must be computer literate, as relative complexities of hardware and software have made the implementation and acceptance of microcomputers much more problematic than, for instance, the overhead projector.<sup>92</sup> It is critical that decisions regarding computer applications for both the classroom and office be made by knowledgeable and intelligent educators - not by computer salesmen and office clerks.

#### Summary

In this chapter, the microcomputer literature related to the following five areas was reviewed: (1) administrative functions; (2) software; (3) hardware; (4) costs; and (5) administrative roles. This section summarizes the chapter findings in order to establish a "state of the art" framework to which the Winnipeg situation can be compared.

While administrative functions of microcomputers would, at first glance, appear to be a never ending list, many of the suggested uses could be considered inefficient and time consuming. Furthermore, practicality dictates limiting microcomputer use to no more than ten applications<sup>93</sup>, each of which should realize a net savings in time and efficiency.

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<sup>92</sup> D.J. Brown and S.A. Cutcliffe, "Administrative Implications of Microcomputers in Education", presented at Canadian Society for Study in Education, Halifax N.S., June 1 - 4, 1981, p. 12.

<sup>93</sup> MECC, "Feasibility Study", op.cit., p. 11.



Areas deemed to be most appropriate for microcomputer application involve a large number of items (or students) and a tedious or repetitive task.

Microcomputer software for administrative use is relatively non-existent at this time, and what little software is available remains unproven and compatible with specific combinations of microcomputers, discs, tapes and printers. Any attempts to modify commercially available business software have been less than successful, with the result that this route is not recommended by the literature. Microcomputer users are advised to either develop administrative programs specific to their school's needs, or to contract their development to a software firm.

Although most microcomputer hardware, as currently available, is dependable and of good quality, prospective purchasers of microcomputers for administrative use are advised to buy one of the more common makes. In order to facilitate administrative applications, these units should feature a minimum of 32K internal memory, external disc storage, and a good quality line printer capable of 30 - 120 characters per second.

Costs, in terms of time, resources, and personnel are very serious considerations for those intending to use the microcomputer for administration. Significant time consumption can be expected for the writing, debugging, and implementation of the required software. Financial resources

will be required to purchase and maintain the microcomputer system. In addition, personnel changes or training can be anticipated as a result of microcomputer applications in areas of educational administration. In light of these various factors it follows that a comparison of expected costs against anticipated benefits is most important for schools considering the microcomputer for administrative use.

The role of the educational administrator will be dramatically affected by the microcomputer.

Administrators will be held more accountable than ever before for a variety of reasons. One can expect their roles as educational leaders to be placed under greater scrutiny as a result of computer assisted management. Similarly, new levels of expectations regarding administrative functions could be expected to exert greater pressure on school administrators.

Considering this change in his/her role and the certainty that the microcomputer will enter his/her school with or without him, the recommended course of action for an administrator is to become computer literate, and thus be capable of monitoring and guiding microcomputer use in his school.

In the next chapter, the findings from the literature are summarized in the form of a framework to guide the investigation of the use of microcomputers for administrative purposes in Winnipeg schools.

## CHAPTER III

### RESEARCH DESIGN AND METHODOLOGY

In this chapter the research design and methodology used in the study are presented. The research design includes the conceptual framework as well as the research questions used to guide the research. The respondents in the study are also described, and the instrumentation utilized in the investigation is presented.

Finally, the research methodology is outlined, including a description of the data collection and treatment methods.

#### Research Design

The major purpose of the study was to determine what variables are involved in the administrative use of microcomputers in schools, and how these variables are being accounted for in Winnipeg schools.

#### Conceptual Framework

This study was initiated in response to an apparent lack of information in the area of microcomputers and school administration - both locally and elsewhere. The concept of first establishing the variables from existing research and literature on this topic, and then comparing the current Winnipeg situation to literature reports and recommendations was thought to be the most effective research design. In addition, it was felt that this research design would be of most use to administrators when beginning microcomputer operations in their schools.

The problem statement of this study suggested ten (10)

questions - two in each of the five areas: (1) administrative functions; (2) software; (3) hardware; (4) costs; and (5) administrative roles. The first question in each area was concerned with the literature findings, and has been answered in Chapter II of this paper. In this way, a conceptual framework has been developed within which the Winnipeg high school situation can be examined. Such a comparison of findings in the literature with the Winnipeg situation gives rise to the second research question in each of the five areas (see Table VIII).

The following were the ten research questions used for the study:

#### Applications

1. What administrative applications of the microcomputer are suggested in the literature by the authorities?
2. To what extent is the microcomputer being used for administrative purposes in Winnipeg schools?

#### Software

3. a) What operating and application software is available, and which of these are recommended by the literature?
- b) What sources of software exist for the prospective user in Manitoba?

4. What software is being used for administrative functions by Winnipeg schools?

#### Hardware

5. What are the options in microcomputer hardware available

TABLE VIII

Correlation of Literature Findings With Second Research  
Question in Each Area

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<u>Issue</u>	<u>Literature</u>	<u>In Winnipeg</u>
Administrative Functions	<ul style="list-style-type: none"><li>-will perform 80% of administrative tasks</li><li>-difficulty with large data base or file manipulation</li><li>-good for tedious or repetitive task</li><li>-use 16-bit machine for scheduling</li></ul>	Research Question #2 (Administrative Functions)
Software	<ul style="list-style-type: none"><li>-most 8-bit machines have CPM operating system</li><li>-Level of BASIC should be high (powerful)</li><li>-little administrative software available</li><li>-users best to develop their own software or pay to have it developed</li></ul>	Research Question #4 (Software)
Hardware	<ul style="list-style-type: none"><li>-choose one of more common makes</li><li>-minimum of 32K internal memory</li><li>-floppy disc storage for administrative use</li><li>-good quality printer of 30-120 char./sec.</li></ul>	Research Question #6 (Hardware)
Costs	<ul style="list-style-type: none"><li>-time, resources, and personnel must be carefully considered</li><li>-financial outlay of \$10,000 or more can be expected</li></ul>	Research Question #8 (Costs)
Administrative Roles	<ul style="list-style-type: none"><li>-microcomputer use for administration inevitable</li><li>-decisions must be made by computer literate administrators</li><li>-administrators will be expected to be more efficient and accountable</li></ul>	Research Question #10 (Administrative Roles)

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for administrative use in schools, and which of these are recommended in the literature?

6. What hardware is being used and recommended by Winnipeg schools using the microcomputer for administrative purposes?

#### Costs

7. What is the cost in time, resources, and personnel to those schools using computer based administrative services?

8. What costs in terms of time, resources, and personnel have been borne by Winnipeg schools using the microcomputer for administration?

#### Administrative Roles

9. What implications will the advent of the microcomputer have upon the role of educational administrators?

10. What implications has the microcomputer had for the role of the educational administrator in Winnipeg high schools?

#### Respondents

Forty-six high schools in the Winnipeg area were identified through the Yellow Pages, Manitoba Telephone System 1980 - 81 directory.

Communication (questionnaire and interview) with these schools was directed through the principal on the premise that he/she would be knowledgeable regarding microcomputer use for administrative purposes in his/her school.

Personal interviews were also held with two local experts in the area of microcomputers and data based manage-

ment systems.

Instrument Development

The answers to the first research questions (#1, 3, 5, 7, and 9) in each of the investigation areas provided a basis for the construction of the Interview Schedule (see Appendix D). The Schedule was used as a guide by the interviewer when conducting personal interviews with personnel involved in microcomputer administrative applications in Winnipeg high schools. The correlation between interview schedule questions and investigation areas is shown in Table IX.

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TABLE IX

Investigation Areas and Interview Schedule

<u>Investigation Area</u>	<u>Interview Schedule Item(s)</u>
1. Administrative Functions	1, 3, 7, 20
2. Software	7, 8, 9, 10, 15, 18
3. Hardware	2, 4, 5, 8, 9, 10, 14, 16, 18
4. Costs	4, 5, 6, 10, 11, 12, 13, 14, 15, 17, 18, 19
5. Administrative Roles	1, 10, 11, 15, 17, 18, 20

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Research Methodology

Initially, a questionnaire (see Appendix C) and covering letter (see Appendix B) were sent to principals of 46 high schools in Winnipeg in November, 1980. Addresses were provided by the Yellow Pages, Manitoba Telephone

system 1980 - 81 directory.

Forty-one (41) of the 46 schools responded, giving a percentage return rate of 89%.

From these results, the schools that were using microcomputers for administration were identified, and personal interviews with administrative personnel in each school followed between February and June, 1981. Telephone interviews were used in December 1981 as a means of updating research information.

Two personal interviews were also held with local experts in the area of microcomputers and data based management systems.

#### Data Treatment

The results of the questionnaire on microcomputer use were collated and used to guide the remainder of the research. Additional observational data was collected through interviews with administrative personnel in the six schools found to be using the microcomputer for administration. This data was then analyzed in the context of the "literature" framework.

The observational data collected and the analysis of the data in the context of the literature findings are both presented in the next chapter.



## CHAPTER IV

### PRESENTATION AND ANALYSIS OF DATA: ADMINISTRATIVE USE OF MICROCOMPUTERS IN WINNIPEG SCHOOLS

The purpose of this chapter is three-fold: (1) to present the observational data collected in the area of administrative use of microcomputers in Winnipeg schools; (2) to compare these observations with the literature findings using the conceptual framework developed in Chapter II as a guide; and (3) to analyze similarities and differences occurring between the literature and the field.

#### Questionnaire Results

The covering letter and questionnaire (see Appendices B and C) were mailed to all 46 high schools in December, 1980. As noted previously, 41 of the 46 high schools responded, giving a return rate of 89%. The results of the microcomputer questionnaire are summarized in Table X. As can be seen from Table X, 19 of 41 schools responding already had a microcomputer in their school. This number, combined with the 8 schools that planned to purchase a machine, meant that 27 schools or 65.8% of those responding would have a microcomputer on site in the very near future. Should this rate of growth continue, all Winnipeg high schools could have microcomputers by 1983.

A further observation was made concerning those schools utilizing the microcomputer for administrative functions and the extent to which other uses were already in place in their schools. All six of these schools were using the microcomputer

TABLE X

Results of Questionnaire on Microcomputer Use

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<u>Question</u>	<u>No. Answering Affirmatively (out of 41)</u>	<u>Percentage</u>
Have Microcomputer in School	19	46.3%
Use Micro for Teaching Computer Courses	17	41.5%
Use Micro for Computer Assisted Instruction	7	17.1%
Use Micro for Administrative Use	6	14.6%
Do Not Have Micro, but Plan to Purchase One	8	19.5%
Have More Than One Micro	6	14.6%
Have Ten or More Micros	2	4.8%

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to teach computer courses, and three of them were using it for computer assisted instruction as well. These observations, combined with the data of Table X indicate that most microcomputers were purchased by schools to be used in the teaching of computer courses, with administrative functions being developed at a later date.

#### Interview Results

The six schools identified as using the microcomputer for administrative functions were visited between February and June, 1981. Information obtained was later updated by means of telephone interviews in December, 1981. In the following brief summaries of the interviews, schools are referred to by number since their identity has no bearing on the research problem pursued in this paper.

##### School #1

School #1 was using a 32K microcomputer for a combination of teaching and administrative functions. The administrative component began gradually, but increased steadily until the need for a new system was evident. At that time a decision was required as to whether to purchase another system to be shared with instructional applications, or to establish a system for the sole purpose of administration. The school staff chose the latter alternative and have recently purchased a 48K microcomputer, dual disc drives, and a letter-quality printer at a cost of approximately \$8000. By following this route the staff hopes to minimize both turn around time and security risks.

While microcomputer operations have been the responsibility of the computer science teacher, it is anticipated that they will soon be absorbed into the routine of regular office staff. This possibility is enhanced by the excellent reliability and dependability of both machines.

At present, the microcomputer assists in the scheduling of 900 students by generating a limited conflict matrix for nearly all students in approximately 10 minutes. A discussion of the scope and limitations of typical microcomputer-produced conflict matrices may be beneficial at this time.

Any conflict matrix represents the options that students select versus the time periods when the courses are offered. The objective in producing the matrix is to minimize the number of conflicts by varying the times, priorities, teachers, and room allocations. Whereas the conflict matrix generated by a main-frame computer may consider all student timetables and allow priority or weighting to be assigned to selected students, a microcomputer's conflict matrix is limited to students with routine timetables and treats them all equally.<sup>94</sup> As a result, this limited conflict matrix requires that students with unusual options be timetabled manually. Further constraints often occur due to the lack of sophistication and small size of most line printers common

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<sup>94</sup> Statement by R. Silver in an address ("Student Scheduling") to Administrator User's Group at Radio Shack Computer Centre; Winnipeg, April 13, 1982.

to microcomputer systems. For example, the conflict matrix for 800 students is printed in strips which must be taped together and often occupies a full wall of space when assembled.<sup>95</sup> Despite these restrictions, microcomputer-produced conflict matrices may be of considerable benefit in student scheduling operations.<sup>96</sup>

Microcomputer applications for locks/lockers and attendance were also in use in this school, and other office systems and routines were under development.

Since most of the administrative software used by this school had been produced by senior students, it was unavailable both commercially and for sharing purposes.

#### School #2

School #2 was actually only in the beginning stages of applying the microcomputer for administration.

The school purchased six 16K microcomputers with tape accessories for about \$700 each. A portion of this initial purchase cost was borne by a Department of Education grant to refurbish the school's Business Education Department.

School personnel have been sufficiently impressed with the reliability of the six machines to order two more with disc drives on the school's current budget.

The security of files was not a concern as hard copy (paper) records were being kept of all information. In addition, the microcomputer used by the office was exclusively

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<sup>95</sup> Ibid

<sup>96</sup> Ibid

for use in the administrative area and was locked up at night.

While the microcomputer was being used only to generate class lists, future plans included the development of test scoring and locks/lockers programs.

### School #3

This school had 3 microcomputers - two of which possessed 16K internal memory, with the remaining machine having 48K internal memory as well as a single disc drive and line printer. The latter unit had been recently purchased by the school division at a cost of approximately \$5000.

Administrative functions that utilized the 48K microcomputer included career day, participation, event scheduling, inventory list, sorting, and substitute programs. Most of these applications involved the storage and retrieval of up to 700 records. The computer functioned well in all applications, but input/output operations were often slow and tedious.

Secretarial staff had been trained in the operation of the larger machine for performing some of their administrative duties once programs were adequately developed.

A project was to soon begin whereby the microcomputer would be connected to the Manitoba Schools Computer Network programs and be able to communicate with the Cybershare computer. In this way data would be uploaded and downloaded to the Network Administrative Programs on Computer-Assisted Scheduling, Mark Recording, and Cumulative Files. Therefore,

the Cybershare computer could perform the necessary operations and return the results to disc units at the school site for access by the microcomputer. It is estimated that the cost for this service, based on required computer time and storage space, could be \$1500 annually.

School personnel felt that any such use of a central computer should minimize security risks since the actual file manipulation occurs away from the school.

#### School #4

School #4 actually used a mini-computer, not a micro-computer, but it is included in this study because of the transient nature of the terms mini and micro, and because of the many similarities between it and the schools previously discussed. Note is also made that the main differences between a minicomputer and a microcomputer involve cost, size of storage, and operating system, and that otherwise the machines function in a similar manner. This minicomputer with 96K internal memory, 3 X 64K bank memory, four terminals, and a high speed printer would market today for in excess of \$20,000. Although the system had been originally purchased by the school board for the teaching of computer science, it was being used for administrative applications as well.

At the time of this survey, the administrative applications of the minicomputer were the responsibility of the school's two computer science teachers. Administrative tasks that had been computerized included mark reporting, attendance, class lists, report cards, test scoring, and

small research project applications. The use of the micro-computer as a word processor was a pilot project at that time.

Strict security measures were necessary with administrative files since students utilized the same machine and a portion of the same memory banks. To this end, summary sheets of file contents were stored in the school office, duplicate records were retained on paper and memory cartridge in two different locations, and the administrative cartridge was locked up at night.

This system had functioned dependably and without breakdown over the two years of use.

#### School #5

This school utilized a microcomputer with 48K internal memory, double floppy disks, and a letter-quality daisy wheel printer. The system had been purchased from school funds and would currently market for approximately \$9500.

This school had been purchasing computer services for reporting, class lists, and attendance, but had not been satisfied with the results. Consequently, they purchased a microcomputer, with the promise of accompanying administrative software, and intended to run it parallel to the purchased services for a trial period before converting completely to the microcomputer system.

At the time of this survey the microcomputer had stored and retrieved 1450 records at one time in printing a student directory. Other uses were planned but were still in the



developmental stages.

The microcomputer system was retained exclusively for office use, was housed there, and was locked up at night with duplicate records being kept on paper in another location.

While the reliability of the system had been questionable due to repeated technical problems, these had been rectified and the microcomputer was reported to be running smoothly.

This school was also involved in a pilot program of the Department of Education for the purpose of assessing science and mathematics software. As a result, 15 to 20 microcomputers with various capabilities were being used throughout the school.

#### School #6

School #6 was using a 48K microcomputer, single floppy disc, and a line printer, and had 3 more such units on order. The unit cost of approximately \$5000 had been funded by the school division approximately one year before the date of this survey. During this time school personnel had been very satisfied with the reliability and general performance of the microcomputer system.

Plans were being formulated to connect this microcomputer to the Manitoba Schools Computer Network Administrative Package. Should this be successful, the Cybershare computer could perform any necessary complex file manipulation or data base operations and relay the resulting data to disc at the school. Therefore, the school would have access to

a sophisticated administrative package through its own microcomputer.

At the time of interview the microcomputer was being operated by one secretary who had been previously trained and employed as a keypunch operator.

When this survey was conducted the school had yet to computerize any administrative applications but had an attendance package under development.

In this school's division, a task force has been formed to study directions in computer education for the division. School personnel were optimistic that forthcoming task force recommendations would provide much needed stability and direction in the area of microcomputer instructional and administrative applications.

Administrative Microcomputer Applications in  
Winnipeg High Schools

Research Question #2 (Applications) was stated as follows:

"To what extent is the microcomputer being used for administrative purposes in Winnipeg schools?"

Findings

Existing administrative applications. Of the 41 schools responding to the initial questionnaire, only 6 (14.6%) of the schools identified themselves as using the microcomputer for administration. Further analysis reveals that the only schools in which microcomputer use for administration was

actually established to any degree were Schools #1 and 4. Thus, out of the 41 schools responding to the questionnaire, only 2 (4.9%) were using the microcomputer in school administration, and only School #4 had been doing so for more than one year.

An analysis of the possible administrative uses of microcomputers (from Chapter II, page 32), feasible administrative uses of microcomputers (from Chapter II, page 35), and actual uses found in Winnipeg high schools is presented in Table XI. As can be seen, there were ten actual administrative applications in Winnipeg and two more were in the developmental stage (indicated by parentheses). It is particularly interesting to note the similarities and differences between these applications and those considered to be most feasible by MECC.<sup>97</sup>

With respect to their diversity, it is probable that many of the applications were initiated due to the interest or expertise of the programming personnel, and were not preceded by a formal needs assessment. As a result, the actual microcomputer uses existing in Winnipeg high schools were scattered over a wide range of administrative functions - many of which would not be considered most feasible.<sup>98</sup> It is equally clear, however, that at least 5 of the 10 actual

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<sup>97</sup> MECC, "Feasibility Study", op.cit., p. 11.

<sup>98</sup> Ibid.

TABLE XI

Possible Feasible and Actual Microcomputer Uses  
for Administration in Winnipeg High Schools

Possible Administrative Function by Microcomputer	Feasible Administrative Function	No. of Actual Uses in Winnipeg
<u>Student</u>		
1. Student Records	X	
2. Census		
3. Enrollment Projection		
4. Attendance (daily)	X	2, (1)
5. Attendance (annual)		
6. Athletic Eligibility List		
7. Health Records		
8. Mark Reporting (transcripts)		1
9. Student Sched. Assistance	X	1
10. Transportation (bus routes)		
11. School Calendar		
12. Graduate Follow-up		
13. Guidance Records		
14. Test Scoring & Analysis	X	
15. Class Lists		3
<u>Personnel</u>		
1. Personal Record		
2. Teaching Assignment	X	
3. "Duty" Lists		3
<u>Facilities</u>		
1. Facilities/Equipment Inventory	X	2
2. Energy Management		
3. Facilities Utilization		
4. Maintenance (schedule of records)		
<u>Finance</u>		
1. General Accounting		
2. Accounts Payable/Receivable	X	
3. Financial Forecasting		
4. Lunch Program Accounting	X	
5. Petty Cash Accounting		
6. Vendor Reports and Purchase Orders		
7. General Ledger	X	
<u>General</u>		
1. Library Circulation		
2. Film Order Lists		
3. Media Reservations	X	
4. Project Planning and Budgeting		
5. Activity Scheduling		
6. Word Processing		(1)
7. Mailing Lists/Labels		
8. Statistical Analysis		1

applications in Winnipeg are in areas deemed most feasible, and may have a greater possibility of success than the others.

Comparison of hardware and expectations. The observational data collected by means of personal interviews is summarized for Schools #1, 2, 3, 5, and 6 in Table XII. School #4 is omitted from this table because it uses a minicomputer to perform its administrative functions. While it is interesting to note that it exists, for the purpose of this analysis I will concentrate on the microcomputer. One further clarification regarding Table XII may be necessary at this time. The term "expectations" in this table refers to all administrative functions that the microcomputer is to perform - both existing and future.

Using the information contained in Table XII and the findings of the literature, it may be possible to analyze each school's chances of success or failure in applying the microcomputer for administration.

School #1. This school was using a 48K microcomputer, dual disc drives, and a letter-quality printer to perform student scheduling assistance (limited conflict matrix), locks/lockers, and attendance applications. According to the literature<sup>99</sup> this school did possess the microcomputer hardware appropriate to their expectations, although they might experience some difficulty in the area of speed constraints as previously described in this paper (Chapter II).

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<sup>99</sup> D.M. Richards, op.cit., p. 17.

TABLE XII

Summary of School Hardware and Expectations

<u>School</u>	<u>School Size</u>	<u>Hardware</u>	<u>Expectations</u>
#1	900	48K microcomputer, dual disc drives, daisy wheel printer	scheduling assistance, locks/ lockers, attendance
#2	1000	16K microcomputer, cassette tape, inexpensive printer	class lists, test scoring, locks/ lockers
#3	700	48K microcomputer, dual disc drives, inexpensive printer	career day, mini- scheduling, invent- ory, sorting, complete Admin. Package by uploading/ downloading to Cybershare
#5	1450	48K microcomputer, dual disc drives, daisy wheel printer	class lists, reporting attendance
#6	700	48K microcomputer, dual disc drives, inexpensive printer	Complete Admin. Package by uploading/ downloading to Cybershare.

School #2. While the administrative microcomputer hardware of this school was limited to a 16K microcomputer, cassette tape, and inexpensive printer, their expectations did not reflect these limitations. In fact, this school expected to implement administrative applications for class lists, test scoring and locks/lockers.

The literature<sup>100</sup> contends that this hardware configuration is capable only of performing calculations of a statistical nature. It would appear that all three hardware components are inadequate for administrative use. The microcomputer should possess the maximum internal memory possible (at least 48K up to 64K)<sup>101</sup>; and the printer should be of good quality capable of 30-120 characters per second.<sup>102</sup>

As a result of all of these factors, it is obvious that this school will experience great difficulties in attempting to effectively utilize their microcomputer for the expected administrative applications.

School #3. This school owned a 48K microcomputer, dual disc drives, and an inexpensive printer. Their expectations of this system included local event scheduling, inventory, and sorting applications, as well as an uploading/downloading procedure with a main-frame computer in order to access a complete administrative package.

Although the microcomputer and dual disc drives will

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<sup>100</sup> Ibid.      <sup>101</sup> Ibid.

<sup>102</sup> MECC, "Feasibility Study", op.cit., p. 10.

support their expectations, it is obvious that the line printer will not.<sup>103</sup> As documented by Richards<sup>104</sup>, a slow printer is hopelessly inefficient and can severely limit administrative applications.

It is also possible that this school could experience considerable difficulty with the microcomputer/computer interfacing as this procedure has not been well-documented by the literature.

School #5. This school was expecting to use a 48K microcomputer, dual disc drives, and a letter-quality printer to perform class lists, reporting and attendance applications for 1450 students. As in the case of School #1, this school possessed the necessary hardware<sup>105</sup>, but could be hampered somewhat by the slowness of the microcomputer.<sup>106</sup>

School #6. In this case the school was intending to use a 48K microcomputer, dual disc drives, and an inexpensive printer to upload and download data to a main-frame computer, and thereby access a complete administrative package. While the microcomputer and disc drives were adequate for this application, the printer definitely was not.<sup>107</sup> Consequently, this school could expect its administrative applications to be severely restricted by the inefficient and poor quality printer.<sup>108</sup>

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<sup>103</sup>Ibid.      <sup>104</sup>D.M. Richards, op.cit., p. 18.

<sup>105</sup>Ibid.      <sup>106</sup>Ibid.

<sup>107</sup>MECC, "Feasibility Study", op.cit., p. 10.

<sup>108</sup>D.M. Richards, op.cit., p. 18.



Conclusion: Research Question #2 (Applications).

Microcomputers in Winnipeg high schools are being used very little for administrative applications at this time.

Although six schools identified themselves as administrative users on the initial questionnaire, only two had progressed to the point of building useful microcomputer functions into their administration, and one of these utilized a minicomputer rather than a microcomputer. Furthermore, the administrative applications of microcomputers which did exist in Winnipeg high schools were not restricted to those considered most feasible by the literature<sup>109</sup>, but rather were spread over a wide range of possibilities.

This picture is further complicated when one considers the hardware possessed by each school and their expectations of that hardware (Table XII). An analysis of the data contained in Table XII reveals that only 2 of the 5 schools had purchased sufficient hardware to support their expectations.

It is appropriate to conclude that Winnipeg high schools are in the very early stages of development in the administrative applications of microcomputers. In fact, this author was unable to see any administrative applications in operation. At best, what I saw were a lot of plans and a lot of dreams, but very little action.

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<sup>109</sup>MECC, "Feasibility Study", op.cit., p. 10.

### Software Used by Winnipeg High Schools

Research Question #4 (Software) was stated as follows:

"What software is being used for administrative functions by Winnipeg schools?"

### Findings

As documented by the literature<sup>110</sup>, commercial software is either unavailable or unproven in this field at this time. It is therefore not surprising that the only sources of software for Winnipeg schools have been their own staff and students.

Of the five microcomputing schools, only school #1 had developed administrative applications to any extent, and they had relied exclusively on both teacher and student produced programs. The users of this software, the school, offered the following four observations to this researcher regarding software: (1) the programs were complex in nature and difficult even for the experienced programmer to follow; (2) the programs were written in BASIC for a 48K system with dual disc drives and up to 1000 records of data; (3) the software was written specifically for the particular needs of the school and was compatible only with its microcomputer system; (4) the authors of the administrative programs were reluctant to share them as they felt that the software had commercial potential.

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<sup>110</sup> MECC, "Feasibility Study", op.cit., p. B-1.

It would appear that all of these observations could be considered characteristic of student and/or teacher produced software. Since the programs were not initially written for a commercial market, it is understandable that they would lack flexibility. Furthermore, since they were written by programmers who are novices, at least in the production of this type of software, one could predict that the programs would be poorly documented, difficult to understand, and inefficient in some areas. The final observation concerning the reluctance to share reflects the tremendous time commitment that these individuals have invested to develop the software that they have. Unfortunately, the programs which they are guarding are of limited scope, and are unlikely to be of any great value on the commercial marketplace.

Conclusion: Research Question #4 (Software)

The small amount of administrative software that did exist for use in Winnipeg high schools was written in BASIC and had been developed locally by teachers and/or students to suit the school's specific requirements. While these programs were reportedly capable of performing a variety of functions, they were unavailable due to the undeveloped commercial marketplace and/or the ownership felt by their authors.

It was clear that the Winnipeg high schools surveyed had relied on local initiatives to produce a small amount of

administrative software for a wide variety of applications.

#### Hardware Used by Winnipeg High Schools

Research Question #6 (Hardware) was stated as follows:

"What hardware is being used and recommended by Winnipeg high schools using the microcomputer for administrative purposes?"

#### Findings

For the purposes of this study it is important to separate School #4 and its minicomputer from the remaining 5 microcomputing schools. Accordingly, discussion of the hardware existing at School #4 will occur at the end of this section.

From the personal interviews conducted it was determined that the five microcomputing schools possessed a variety of microcomputers, methods for external storage, and line printers.

Microcomputers. While the brand of microcomputer was not important to this study, it is noted that there were two Apple II's, one PET, one TRS-80, and one Northstar distributed throughout the five microcomputing schools. The reliability of these machines had been excellent except for the technical problems experienced by School #5.

It is important to note that School #5 was the only school not using a more common brand of microcomputer as had been recommended by the literature<sup>111</sup>, and that this

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<sup>111</sup>S. Ropes and H. Gaylord, op.cit., p. 104

choice severely limited the establishment of administrative applications in the school. While the eventual replacement of a defective chip seemed to have solved their technical problems, they still lacked the necessary administrative software. This software had been promised by the supplier at the time of purchase, but had yet to materialize. The possibility that such software would become commercially available for this machine was hampered by its uncommon make. It is clear that a poor choice of microcomputer can severely restrict administrative applications in a school.

Internal storage of 48K existed on the microcomputers found in Schools #1, 3, 5, and 6, but School #2's machine was supported only by 16K, and could therefore be expected to restrict the administrative applications of that school.<sup>112</sup>

Methods for external storage. While Schools #1, 3, 5, and 6 possessed single or double floppy disc drives for external storage, School #2 relied on cassette tape for this function. The literature<sup>113</sup> predicts that School #2's dependence on cassette tape will severely limit its administrative applications.

Printers. Although all five microcomputing schools had line printers, only Schools #1 and 5 had good quality machines capable of 30-120 characters per second as recommended by the literature.<sup>114</sup> Therefore, it could be expected that

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<sup>112</sup> MECC, "Feasibility Study", op.cit., p. 2.

<sup>113</sup> D.M. Richards, op.cit., p.15.

<sup>114</sup> MECC, "Feasibility Study", op.cit., p. 10.

Schools #2, 3, and 6 would experience some constraints due to printer speed and quality when attempting to apply the microcomputer for administration.

The minicomputer of School #4. The minicomputer owned by School #4 was very conspicuous due to its price, memory storage, and program capabilities. This 16-bit system possessed 96K internal storage, 3x64K external bank memory, and was supported by a high speed printer. As reported by the literature <sup>115</sup>, such 16-bit microprocessors will greatly enhance administrative microcomputer possibilities, and should be seriously considered by prospective microcomputer purchasers.

It would appear that the minicomputer and related hardware in place at School #4 would be more than adequate for any administrative applications involving its 250 students.

Conclusion: Research Question #6 (Hardware)

Microcomputer hardware being used for administrative purposes in Winnipeg schools varies from the smaller 16K personal or hobby type system to the refined and more powerful minicomputer. While it is interesting to note that the latter system possessing internal memory of 96K and bank memory of 192K exists, it will be excluded from the following discussion since the purpose of this paper is to concentrate on the microcomputer.

Four of the remaining five schools had microcomputers

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<sup>115</sup>G. Evans, loc.cit.

with 48K internal memory and disc drives for external storage. The exception was School #2 with a 16K machine and cassette tape storage.

Printer hardware showed similar variations in sophistication with only Schools #1 and 5 utilizing good quality printers capable of 30 - 120 characters per second.

In general, Winnipeg schools were using the more common makes of microcomputers, and had been well satisfied with the mechanical reliability of their machines. However, any recommendations by Winnipeg schools regarding this hardware and its suitability for administrative use would have been premature due to the early stage of development in this area.

Costs of Using the Microcomputer for Administration in  
Winnipeg High Schools

Research Question #8 (Costs) was stated as follows:

"What costs in terms of time, resources, and personnel have been borne by Winnipeg schools using the microcomputer for administration?"

Findings

When commencing this study, it was expected that a number of common difficulties in implementing microcomputer administrative use would have been experienced by Winnipeg high schools. In fact, questions 4 through 18 with the exception of 6, 8, and 14 of the Interview Schedule are all related to some cost in terms of time, resources or personnel. A comparison of the anticipated costs and those actually found to exist is located in Table XIII. Analysis of this table reveals that many of the

TABLE XIII

Anticipated and Actual Costs with School-based  
Micros for Administrative Use

<u>Anticipated Cost</u>	<u>Evidence of Actual Cost (by #)</u>
<u>Time</u>	
1. Difficulty finding time to write the necessary software	2,3,5,6
2. Slow data access	1,3
<u>Resources</u>	
1. Difficulty obtaining necessary funds	
2. Sharing with students resulting in security problems	4,6
<u>Personnel</u>	
1. Difficulty in training office personnel	2,5
2. Difficulty with availability/interest of qualified staff to write required software	2,3,5,6



expected costs were not, in fact, realized by the Winnipeg high schools.

Concerns in the area of time costs were expressed by Schools #2, 3, 5, 6 and centred around the lack of time available to write the required software. It is interesting that further time constraints in terms of slow data access were experienced by Schools #1 and 3, and that both of these schools shared their computer between administrative and student applications.

Difficulties with the availability of financial resources were not a major concern of any personnel interviewed. Schools #1, 2, and 5 had purchased microcomputers to support computer science programs either from within their own school budgets or from Department of Education grants for related programs. Schools #3, 4, and 6 received their computers from their school division which also made the choice of hardware. Although none of the schools interviewed expressed concern regarding the availability of financial resources for initial microcomputer purchases, many of them were seeking funds to expand their operations.

Schools #4 and 6 were somewhat concerned that shared student-administration arrangements may have created some security risks with confidential information. In this regard it is probable that the purchase of a microcomputer for the exclusive use of the school office would have resolved these difficulties.

Concerns regarding personnel costs were evident in Schools #2 and 5 where some difficulty had been encountered in training office personnel to operate the microcomputer. This problem and that of Schools #2, 3, 5, and 6 regarding the interest of available staff in writing programs and/or managing computer operations might both be reduced by further administrative commitment to microcomputer use.

Conclusion: Research Question #8 (Costs)

Major difficulties in implementing microcomputers for administrative use in Winnipeg high schools have centred around two cost factors: (1) production of software, and (2) commitment of qualified personnel. It is obvious that the first of these concerns depends directly upon the second. In other words, when the administrative, teaching and clerical staff are committed to the administrative application of microcomputers, the time and energy required to create the necessary software may be forthcoming.

Further cost items of a lesser nature have occurred in the areas of training operating staff, slow access to data, and security as a result of sharing arrangements.

In general, in the very early stages the actual costs are similar to those reported by the literature.<sup>116,117</sup>

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<sup>116</sup>D.M. Richards, op.cit., p. 15.

<sup>117</sup>D.G. Marshall, "School Administrator and the Microcomputer", op.cit., p. 13.

Changes in the Role of the Educational Administrator in  
Winnipeg High Schools

Research Question #10 (Administrative Roles) was stated as follows:

"What implications has the microcomputer had for the role of the educational administrator in Winnipeg high schools?"

Findings

Only Schools #1 and 4 of the schools surveyed have developed the administrative use of microcomputers to any extent, and in these two schools, as in several others, computer operations have been the responsibility of computer science teachers. At the time of this study, neither school had assessed the impact of the microcomputer on the role of administration, but both expected it to be relatively small due to the early stage of development in administrative microcomputer applications.

While the level of computer literacy in administrators was difficult to assess, it was interesting to note that only in Schools #3 and 6 were the administrators directly involved in the writing of programs.

Conclusion: Research Question #10 (Administrative Roles)

In this early stage of development, microcomputer use for administration by Winnipeg high schools does not appear to have had any significant effects on the role of the educational administrator.

## Comparison of the Literature and the Field

The purpose of this section is to answer the major research problem which was stated as follows:

"The purpose of this study was to determine what variables are involved in the administrative use of microcomputers in Winnipeg schools, and how these variables are being accounted for in Winnipeg schools."

In this section the literature findings are compared to the actual administrative use of microcomputers in Winnipeg high schools by using the conceptual framework and the five investigation areas as a guide. This comparison is summarized in Table XIV which is an extension of Table VIII (page 96.)

### 1. Administrative Functions

As discussed in Chapter II, the microcomputer possesses the potential to perform approximately 80% of the administrative tasks in a school. While it may be impractical to utilize the microcomputer for some of these functions, there is evidence that its use for any of the ten most feasible applications (see Table XI) would assist administrators significantly.

From the previous section it can be concluded that there has been very limited use of the microcomputer for administration in Manitoba schools. In addition, the few applications implemented by the schools surveyed have been in a wide variety of areas - many of which are not considered to be the most feasible by the literature (see Table XI). As a result, one could conclude that administrative applications in Winnipeg

TABLE XIV

Comparison of the Literature with the Field in Each Area

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<u>Issue</u>	<u>Literature</u>	<u>In Winnipeg</u>
Administrative Functions	<ul style="list-style-type: none"><li>-will perform 80% of administrative tasks</li><li>-difficulty with large data base or file manipulation</li><li>-good for tedious or repetitive tasks</li><li>-use 16-bit machine for scheduling</li></ul>	<ul style="list-style-type: none"><li>-performing limited attendance, mark reporting, class lists, etc.</li><li>-no student scheduling functions</li><li>-only one 16-bit machine</li><li>-very little development</li></ul>
Software	<ul style="list-style-type: none"><li>-most 8-bit machines have CPM operating system</li><li>-level of BASIC should be high (powerful)</li><li>-little administrative software available</li><li>-users best to develop own software or pay to have it developed</li></ul>	<ul style="list-style-type: none"><li>-many different systems with different levels of BASIC</li><li>-very little admin. software developed or available</li></ul>
Hardware	<ul style="list-style-type: none"><li>-choose one of the more common makes</li><li>-minimum of 32K internal memory</li><li>-floppy disc storage for administrative use</li><li>-good qual. printer of 30-120 char./sec.</li></ul>	<ul style="list-style-type: none"><li>-mostly Apple, TRS-80, and PET machines with variety of internal memories</li><li>-some disc and tape storage</li><li>-mostly poor quality printers</li></ul>
Costs	<ul style="list-style-type: none"><li>-time, resources, and personnel must be carefully considered</li><li>-financial outlay of \$10,000 or more can be expected</li></ul>	<ul style="list-style-type: none"><li>-mostly small financial outlays</li><li>-time and/or personnel shortage in many schools</li><li>-limited resources often results in sharing with students</li></ul>
Administrative Roles	<ul style="list-style-type: none"><li>-microcomputer use for administration inevitable</li><li>-decisions must be made by computer literate administrators</li><li>-administrators will be expected to be more efficient/accountable</li></ul>	<ul style="list-style-type: none"><li>-administrators mostly computer illiterate</li><li>-too early in development to assess effect on administrative role</li></ul>

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schools reflect a disjointed and rather minimal implementation effort.

Although it is difficult to determine the reasons for this early stage of development, it is obvious that the newness of the area is a major contributing factor. However, an additional and not so obvious cause may well be the relatively high expectations demanded of inadequate hardware common to some users. For example, 3 of the 5 microcomputing schools interviewed did not possess the microcomputer hardware necessary to support their expectations, and thus had achieved very little in the area of administrative use of the microcomputer. Conversely, the one school which had been successful in developing useful administrative applications (School #1) possessed the necessary hardware recommended by the literature<sup>118</sup>, and developed several of the applications considered to be the most feasible<sup>119</sup>.

Although School #1 utilized a limited conflict matrix to assist in student scheduling, no Winnipeg schools used the microcomputer for complete student scheduling functions. This fact could have been predicted since the literature was quite specific on the unsuitability of the 8-bit machine for large data base and file manipulation operations.<sup>120</sup> In

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<sup>118</sup> D.M. Richards, op.cit., p. 17.

<sup>119</sup> MECC, "Feasibility Study," op.cit., p. 10.

<sup>120</sup> G. Evans, loc.cit.

fact, the 16-bit minicomputer is recommended for student scheduling operations. <sup>121</sup>

It is clear that the same constraints cited by the literature have influenced Winnipeg schools and have severely restricted the development of the administrative functions of microcomputers.

## 2. Software

As discussed in Chapter II, software is of two types - operating and application.

a) Operating software. This area consists of both the operating system and the computer language(s).

Discussion of operating systems by the literature focused on the existence of the CPM system contained in the majority of brands of 8-bit microcomputer on today's market. <sup>122</sup> Although most personnel interviewed in Winnipeg schools were not aware of the specific operating system used by their microcomputer, it is interesting to note that only School #1 utilized a machine run by the CPM operating system. <sup>123</sup> The literature referred to the possibility of two CPM driven machines communicating if interfaced with an auxiliary system called Turbodos, <sup>124</sup> but such operations are clearly not for Winnipeg high schools since CPM hardware appears to be the exception and not the rule. In fact, Winnipeg high school users expressed interest not in

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<sup>121</sup> Ibid.

<sup>122</sup> Ibid.

<sup>123</sup> D.M. Richards, op.cit., p. 16.

<sup>124</sup> G. Evans, loc.cit.

communicating with each other, but in communicating with a main-frame (Schools #3 and 6). The nature of the required interface for this operation was not known at the time of the interviews.

In general, Winnipeg high schools had been satisfied with the performance of the operating systems used by their microcomputers.

Concerning computer languages, the literature recommended that microcomputers possess a full version of the BASIC language that supports all or most of the features found in Table V.<sup>125</sup> Winnipeg high school microcomputers employed a wide range of levels and editions of the BASIC language, but the power of their particular language had yet to be determined by the users. In general, personnel were unaware of the different levels of BASIC and had accepted the language(s) purchased with the machine without attempting to enhance or expand them.

In the area of operating software, it would appear that the microcomputers purchased by Winnipeg high schools possess operating systems and computer languages capable of meeting their needs.

b) Application software. As previously noted by the literature, there exists an enormous void in the area of commercially available software for administrative purposes.<sup>126</sup> This fact, combined with the low priority given to this area

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<sup>125</sup> MECC, "Microcomputer Report", op.cit., p. 77.

<sup>126</sup> K. Billings, op.cit., p. 102.



by Winnipeg high schools, has resulted in the only administrative software in Winnipeg schools being produced by school staff and/or students. For example, in School #1 which has developed three administrative applications of the micro-computer, students wrote one program and staff wrote the other two. While I was unable to see any software when I visited the school, it was clear that a great time expenditure had been necessary to develop each application. The literature had predicted these large blocks of time<sup>127</sup>, and had also reported that the resulting software is often of poor quality and documentation.<sup>128</sup> The latter possibility was not investigated by this author as software was unavailable for inspection.

In any case, it would seem that the findings from the literature in the area of administrative software are generally reflected in the experiences of Winnipeg high schools.

### 3. Hardware

Most of the microcomputers found in Winnipeg schools are, as the literature suggests, the more common brands<sup>129</sup> possessing internal memories of 32K<sup>130</sup> or more, and employing floppy disc units for external storage.<sup>131</sup> It is interesting to note

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<sup>127</sup> D.G. Marshall, "School Administrators and the Microcomputer", op.cit., p. 13.

<sup>128</sup> K. Billings, op.cit., p. 101.

<sup>129</sup> G. Ropes and H. Gaylord, op.cit., p. 104.

<sup>130</sup> MECC, "Feasibility Study", op.cit., p. 2.

<sup>131</sup> D.M. Richards, op.cit., p. 17.

that two of the exceptions, School #2 with a 16K machine and School #5 with an uncommon brand, have not been successful in developing any administrative applications for their microcomputers.

Similarly, the most successful microcomputing school (ignoring School #4's minicomputer) was School #1 which also possessed a high quality line printer capable of 30 - 120 characters per second as recommended by the literature.<sup>132</sup> School #5 also owned a high quality printer, but had incurred technical problems with its microcomputer (an uncommon brand). As well, School #4 utilized a very fast high quality printer, but is excluded from this discussion due to its minicomputer.

It is clear that the literature recommendations in the area of microcomputer hardware have held true for the Winnipeg schools.

#### 4. Costs

As discussed earlier, the literature describes the costs of microcomputer use in three areas: time, resources, and personnel.

a) Time. The time consumption costs described by the literature basically involve activities of three types: researching and preparing for microcomputer operations in administration<sup>133</sup>; writing the required software<sup>134</sup>; and

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<sup>132</sup> MECC, "Feasibility Study", op.cit., p. 10.

<sup>133</sup> P.P. McGraw, op.cit., p. 7.

<sup>134</sup> D.G. Marshall, "School Administrator and the Micro-computer", op.cit., p. 13.

waiting for the microcomputer to generate the required output.<sup>135</sup> At first glance one might surmise that these costs of microcomputer use have yet to be experienced by Winnipeg high schools due to their early stage of development. However, upon closer inspection it can be seen that all three cost areas have presented severe limitations to the development of administrative applications in these schools.

In the first case of researching and preparing for administrative microcomputer applications, it is obvious when one compares the actual Winnipeg uses to those recommended (Table XI) that this field has not been properly researched by Winnipeg high schools. In fact, the interview results indicate the existence of many dreams (Table XIII), but few plans of action.

The second area referred to by the literature concerned the time required to write the necessary software. This concern has certainly been restrictive in Schools #2, 3, 5 and 6 in Winnipeg schools (see Table XIII).

Similarly, Schools #1 and 3 have experienced slow data access difficulties (Table XIII) as suggested in the third time constraint cited by the literature.

In conclusion, it can be stated that the same time consumption costs referred to in the literature have been experienced to a significant degree by Winnipeg high schools.

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<sup>135</sup> MECC, "Feasibility Study ", op.cit., p. 9.

b) Resources. The literature recommends that potential administrative users purchase microcomputers which allow for expansion<sup>136</sup>, and which would cost approximately \$5000 as an initial expenditure. While none of the interviewed personnel voiced concern regarding a shortfall of funds, it is true that Schools #1 and 5 had purchased microcomputer systems suitable for administrative use, and that School #1 had been the most successful of the Winnipeg microcomputing schools. Schools #4 and 6 had experienced difficulties due to shared student-administrative use of one machine (Table XIII). Both of these observations suggest that microcomputer use for administration in Winnipeg schools would be greatly enhanced by a larger commitment of financial resources.

c) Personnel. Concerns reported in the literature regarding personnel costs centred around the availability/interest of qualified staff<sup>137</sup>, and the level of computer literacy in administrators.<sup>138</sup>

On the first point, it is clear that Schools #2, 3, 5 and 6 have experienced problems with software production by existing staff (Table XIII). In this respect, the Winnipeg schools again reflect the literature findings.

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<sup>136</sup> P. Stark, op.cit., p. 117.

<sup>137</sup> D.G. Marshall, "Purchasing a Microcomputer System", op.cit., p. 15.

<sup>138</sup> Univ. of Oregon, op.cit., p. VI.A.2.

However, the second concern regarding the level of computer literacy of administrators was not reported by or evident in Winnipeg schools when interviews were conducted. This is not to say that Winnipeg administrators are considered to be computer literate, but rather that their level of literacy was not identified as a problem by the interviewed personnel.

#### 5. Administrative Roles

As previously discussed (Chapter II), the literature identifies a number of areas of concerns for the school administrator's role in the context of the advent of the microcomputer.<sup>139</sup> Since all of these concerns involve ways in which the microcomputer will influence society and/or the school administrator, it is logical to assume that very little will have occurred in an area where the administrative use of microcomputers had barely begun. In fact, this was found to be the case in the Winnipeg high schools visited.

In this chapter, the data has been presented and analyzed in order to answer the research question that guided this investigation.

In the next and final chapter some conclusions and recommendations regarding administrative use of microcomputers in Manitoba schools are proposed.

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<sup>139</sup> D.G. Marshall, "School Administrator and the Microcomputer", op.cit., p. 4.

## CHAPTER V

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this chapter is to present (1) a summary of the study and its findings, (2) some conclusions based upon the findings, (3) recommendations for future action, and (4) suggestions for further study.

#### Summary

##### Study, Purpose, Focus and Problem

##### Statements

Purpose. The major purpose of this study was to determine what variables were involved in the administrative use of microcomputers in schools, and how these variables were being accounted for in Winnipeg schools.

Focus of the study. The particular focus of this study was a consideration of the variables involved in the administrative use of microcomputers as reported by the literature and experienced by the field. The literature findings were used to develop a conceptual framework which was then compared to the research findings in order to arrive at a state of the art analysis of the Winnipeg situation.

The problem statement of the study suggested ten (10) research questions - two in each of the following five investigation areas: (1) administrative functions; (2) software; (3) hardware; (4) costs; and (5) administrative roles. The first research question in each area was concerned with

the literature findings (Chapter II), while the second was concerned with the state of development in Winnipeg high schools (Chapter IV). The following ten research questions were used for the study:

#### Applications

1. What administrative applications of the microcomputer are suggested in the literature by the authorities?

2. To what extent is the microcomputer being used for administrative purposes in Winnipeg schools?

#### Software

3. (a) What operating and application software is available, and which of these are recommended by the literature?

(b) What sources of software exist for the prospective user in Manitoba?

4. What software is being used for administrative functions by Winnipeg schools?

#### Hardware

5. What are the options in microcomputer hardware available for administrative use in schools, and which of these are recommended by the literature?

6. What hardware is being used and recommended by Winnipeg schools using the microcomputer for administrative purposes?

#### Costs

7. What is the cost in time, resources, and personnel by those schools using computer based administrative services?

8. What costs in terms of time, resources and personnel have been borne by Winnipeg schools using the microcomputer for administration?

#### Administrative Roles

9. What implications will the advent of the micro-computer have upon the role of educational administrators?

10. What implications has the microcomputer had for the role of the educational administrator in Winnipeg high schools?

#### Study Respondents

The respondents for the purposes of this study consisted of the principals of 46 Winnipeg high schools as found in the Manitoba Telephone System Yellow Pages Directory, 1980-81.

#### Instrument Development

The answers to the first research questions in each of the five investigated areas provided a basis for the construction of the Interview Schedule (Appendix D). The Interview Schedule was used as a guide for the interviews with personnel involved in microcomputer administrative applications in Winnipeg high schools.

#### Data Collection

Initially, data were obtained by mailing individual questionnaires (Appendix C) to principals of 46 Winnipeg high schools. Completed questionnaires were received from forty-one (89%) of the schools surveyed.

From these results, six schools were identified as using



the microcomputer for administration. Personal interviews with personnel involved followed.

Two personal interviews were also held with experts in the field.

#### Data Treatment

Results of the questionnaire on microcomputer use were collated and used to guide further research.

Results of the personal interviews held in schools were summarized and reported by individual school and subsequently contributed to the general observations and recommendations of this study.

#### Summary of Research Findings

The nature of the research questions suggested two major study tasks. The first task was prescribed by the first research question in each investigation area and involved describing the current theoretical state of the art as derived from the literature review. This information was presented in detail in Chapter II. The second research question in each investigation area prescribed the tasks of describing and examining the Winnipeg high school situation as it was found to exist. This information is presented in detail in Chapter IV. The following is a summary of the observations with regards to each investigative area.

#### Applications

The extent to which microcomputers can be used administratively is yet to be determined. While microcomputers may

be expected to perform approximately 80% of the required administrative tasks, problems do arise when large data base or file manipulation operations are considered. Even with these limitations, the microcomputer can still be very effective when used for a large number of items and for the performance of tedious or repetitive tasks.

Microcomputers are being used very little for administration at the present time in Winnipeg high schools. In addition, many of the administrative applications which did exist in these schools were not deemed most feasible by the literature.

Clearly, Winnipeg high schools are in the very early stages of development in the administrative application of microcomputers.

#### Software

Most brands of 8-bit microcomputers employ the CPM operating system which, when interfaced with a Turbodos system, allows them to communicate with others. All microcomputers employ some version of the BASIC computer language, but the power of each version varies from machine to machine.

Since proven administrative software is not yet available, most writers suggest that users develop their own software, or pay to have it developed.

The limited administrative software being used in Winnipeg high schools has been developed locally by the

individual schools.

#### Hardware

A microcomputer should be one of the more common makes and be supported by: (a) a minimum of 32K memory; (2) external storage in the form of floppy disc; and (3) a good quality line printer (30 - 120 characters per second).

Microcomputers being used in Winnipeg high schools vary from the smaller "hobby" type system (16K internal memory) to the powerful minicomputer (96K internal memory). Printers and external storage devices show similar variations. Schools successfully using the microcomputer for administration recommend a minimum of 32K internal memory, bank or disc external memory, and a good quality line printer.

#### Costs

Expected time, resource, and personnel costs must be carefully appraised by knowledgeable personnel at the outset of computer operations. Whether potential users are considering financial or human resources, they must critically and realistically weigh the sum total of input necessary against the output expected.

Difficulties experienced by Winnipeg schools in developing the microcomputer for administrative use have centred around the lack of both available software and necessary personnel.

#### Administrative Roles

The role of the educational administrator will experience significant change as a result of the advent of the microcomputer. In particular, the microcomputer will be expected to

assume some plant management functions leaving the administrator more available for the educational leadership role. As a result, administrators will be held more accountable than ever before.

In this early stage of development, the very limited microcomputer use in Winnipeg high schools has not appreciably affected the role of the educational administrator.

### Conclusions

The review of the related literature on administrative uses of microcomputers and the situation found to exist in Winnipeg high schools provided the basis for the following conclusions:

1. The great potential which exists for the administrative use of the microcomputer has not been developed significantly by Winnipeg high schools.
2. Operating software available to microcomputer users is varied but adequate.
3. Since administrative software up to the time this study was conducted has been commercially available to only a limited extent, Winnipeg high schools have attempted to develop their own - with very limited success.
4. In general, Winnipeg high schools have not acquired the necessary microcomputer hardware to facilitate administrative applications.
5. While the costs of microcomputer based administrative services may be high, up to this point expenditures by

Winnipeg high schools in this area have been relatively limited.

6. The role of the Winnipeg administrator has yet to be affected by the microcomputer.

#### Recommendations

The literature review combined with the existing Winnipeg situation led to the following recommendations pertaining to the use of microcomputers for administration by Manitoba schools.

1. The Manitoba Department of Education, Computer Services Branch, should provide leadership in the development of administrative software. Such initiatives could include:

a) Cooperating with local school boards to appoint sufficient consultants/coordinators to assist schools in all aspects of microcomputer literacy and applications.

b) Contracting for the development of microcomputer administrative software packages.

c) Evaluation and documentation of commercially available administrative software packages.

d) Keeping the community informed of advances in administrative software.

2. All parties involved in computer or microcomputer operations at the school level should make a strong effort to establish and maintain lines of communication with each other, and to share their experiences and expertise.

3. The Manitoba Department of Education should undertake

and distribute an evaluation of 8 and 16 bit micro-hardware currently available, along with current price information and possible bulk purchase price.

4. Schools considering administrative use of the microcomputer should be encouraged to purchase 16-bit machines.

5. Schools which are considering the microcomputer for administrative use should undertake a thorough needs assessment before purchasing the necessary hardware. Instruments and personnel to assist in this assessment should be available from the Manitoba Department of Education and the Faculties of Education at the Universities.

6. The Manitoba Department of Education should initiate studies in the area of micro-mainframe interfacing and its feasibility for administrative applications.

#### Suggestions For Further Study

Results of this study indicate a need for further research in the following areas:

1. Needs assessment for computer based administrative services in Manitoba.

2. Technical feasibility studies of microcomputer use for school administration.

3. Microcomputer hardware and software evaluation and pricing information.

4. Study of the comparative potentials of the 8 and 16 bit microcomputers.

5. In-service methods and techniques for arriving at various levels of computer literacy.

APPENDIX A  
GLOSSARY OF COMPUTER TERMS



# A Selected Glossary of Terms Useful in Dealing with Computers<sup>140</sup>

Charles H. Douglas and  
John S. Edwards

This glossary attempts to explain terms with which one needs to be familiar in order to function successfully in the microcomputer environment. The terms have been selected from advertisements, catalogs, microcomputer manuals, dictionaries, textbooks, and conversations with persons who work with microcomputers. We have tried to interpret the definitions in non-technical language. In those cases where this was not possible, technical terms used in definitions were included as entries in the glossary. These terms are italicized in the text of the definitions. We have also included a cross-reference category to refer the reader to terms which are closely related to the entry term. Hopefully this glossary will provide a launch pad from which you may pursue knowledge and use of microcomputers to the extent of your needs.

## GLOSSARY

### ACCESS TIME

The interval of time between the calling for information from a *storage address* and the delivery of that information. In general, *tape* has a longer access time than *disc* (or *disk*, as it is sometimes spelled).

### ACOUSTIC COUPLER

A device attached to a *computer terminal* to transmit and receive audio tones via telephone lines. A type of *modem*.

### ADDRESS

A label (name or number) that designates a location where information is stored in a *memory device*.

### A/D INTERFACE

A/D (Analog/Digital) A circuit which changes an input voltage fluctuation (continuous), such as results from a

musical tone, into digital information (discrete) for processing by the computer. It also converts digital information to analog.

### ALGORITHM

An orderly step-by-step procedure, like a recipe, that consists of a list of *instructions* for accomplishing a desired result, or for solving a problem. Usually expressed in mathematical terms. In computer programming, an algorithm is expressed as a *flowchart*.

### ALPHANUMERIC

A set of symbols. Can be letters (A-Z) and/or numerals (0-9), and/or special punctuation, mathematical, or *graphic symbols*.

### ARCHITECTURE

The internal, preset arrangement or organization of a computer which determines how the computer operates. The interconnections of registers, logic units, control logic, etc. That which makes one *microprocessor* different from another.

### ASCII

Pronounced "Ask-ee." American Standard Code for Information Interchange. *Binary number codes* for letters, numbers, symbols, and special characters that have been accepted as standard by the computer industry. This standard specifies which number will stand for each character. All *personal computers* use this standard. SEE: BAUDOT CODE, BCD CODE.

### ASSEMBLER

A program which converts English commands or expressions, usually in mnemonics, into machine language in *binary form* for processing by the computer. Assembler language and *assembly language* are synonymous.

### ASSEMBLY LANGUAGE

A *computer language* that uses mnemonic names to stand for one or more *machine language* instructions. Assembly language is similar to "shorthand," used to avoid the tedious use of long strings of zeros and ones found in machine language. The advantage of using assembly language instead of a *high-level language*, such as *BASIC*, is speed of execution, but a high-level language is usually easier for a human being to understand.

### AUXILIARY MEMORY (STORAGE)

Storage available in a computer, in addition to its own memory banks; it can be either *disc* or *tape*. SEE: MASS STORAGE.

### BASIC

An acronym for *Beginners All Purpose Symbolic Instruction Code*. A *high-level* conversational, interpretive, programming language in wide use. Always written in capital letters, BASIC was invented by Kemeny and Kurtz at Dartmouth College in 1963. It permits the use of simple English words and common mathematical

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symbols to perform the necessary arithmetic and logical operations to solve problems.

#### BASIC-IN-ROM

This term indicates that the programming language *BASIC* has been stored in *ROM Memory*.

#### BATCH PROCESSING

A method of processing information in logical groups.

#### BAUD

A rate of information flow. Given in *bits per second* (bps), the rate is the highest number of signal elements (bits) that a device is capable of transferring in one second between two devices. Alphabetic characters, for example, being transferred at 300 baud corresponds to about 30 characters per second. Common baud rates are 110, 150, 300, 600, and 1,200 bps.

#### BAUDOT CODE

An obsolete processing code which uses five separate *bits* to represent a given character. SEE: ASCII, BCD CODE.

#### BCD CODE

*Binary Coded Decimal*. A *code* which uses five *bits* for each character. SEE: ASCII, BAUDOT CODE.

#### BELT PRINTER

A printer which uses a steel belt with character impressions; the belt rotating at high speed. When a desired character is in the correct position, it is struck from behind with a stationary "hammer," thus imprinting the character on the paper. The belt printer forms a solid character. SEE: DAISY WHEEL PRINTER, INK JET PRINTER, MATRIX PRINTER.

#### BINARY CODE

*Code* using only zero and one to represent data. SEE: ASCII, BAUDOT CODE, BCD CODE.

#### BINARY SYSTEM

A number system based on the number 2, just as the decimal system is based on the number 10. The binary system is represented by the digits 0 and 1, and each place in a number represents a power of 2. SEE: HEXADECIMAL SYSTEM, OCTAL SYSTEM.

#### BIT

*Binary Digit*. The smallest unit of digital information. It has only two states: zero and one. A bit can be thought of as representing: a yes/no choice, a distinction between true and false, or whether a circuit is on or off.

#### BOOTSTRAP

A short sequence of *instructions* which, when executed by the *computer*, will automatically allow another longer program to be loaded from an input *peripheral* to the programmable *memory* of the *CPU*.

#### BPS

*Bits Per Second*. SEE: BAUD.

#### BRANCH

A place in a *program* where a choice is made to depart from the normal sequence of *program instructions*. The departure is made by a "branching instruction" in the program. A branching instruction may be one of two types: conditional or unconditional. In *BASIC*, an example of the first type is: IF . . . THEN; of the second type is: GO TO.

#### BUFFER

A space in a computer system where information is temporarily stored. Usually used to store small sections of data during a transfer process. For example, data may be *read* from a tape cassette in small units, placed in a buffer, then transferred to *main memory* when the *computer* is ready to process the data.

#### BUFFERED I/O

Input/Output operations using a *buffer* to increase speed. Because of the slowness of *I/O* devices, information is held in the *buffer* until enough has accumulated to make it worthwhile for the extremely fast *CPU* to act. SEE: BUFFER.

#### BUG

An error in programming which causes faulty outputs. May also mean a *hardware* malfunction or design error either in the *computer* or in its *peripherals*. SEE: DEBUG.

#### BULK STORAGE

Synonymous with *mass storage*.

#### BUS

A physical connection of parallel wires providing a communication line along which data can be sent. Usually shared by several parts of the computer. An S-100 Bus has 100 lines. In a unidirectional bus system, signals from one or more sources, activated one at a time, drive a common load or loads. A bidirectional bus system lets signals go either way on the bus, again activated only one at a time. Most *microprocessor* data uses are bidirectional.

#### BYTE

The basic unit of information in a computer. Commonly consists of a sequence of eight binary *bits*, usually handled as a unit. One byte usually represents one character. SEE: BINARY SYSTEM, WORD.

#### CASSETTE RECORDER

A device for preserving internally-stored information. Because most computers lose the information stored in them when they are turned off, a means of keeping the information is necessary. *Binary* information is stored on a *cassette tape* by first converting it to audio signals and recording it on the tape. This method of storage is slower than *discs*. SEE: MEMORY.

**CHARACTER**

Single items that can be arranged in groups to stand for information. There are two forms: (1) numbers, letters, *graphic* symbols, etc., that can be understood by human beings, and (2) groups of *binary digits* that can be understood by the computer. A character is usually represented by one *byte*.

**CHARACTER CHECKING**

A procedure for examining each individual character or group of characters to check for accuracy and consistency.

**CHARACTER SET**

Refers to the characters available to a *computer*, *printer*, or *terminal*. Some devices have only upper case letters plus numbers and a few special characters such as punctuation, #, 1, etc. Others have upper and lower case letters, numbers, and many special characters which may be combined to form designs. SEE: CHARACTER, GRAPHICS.

**CHIP**

The heart of a *microcomputer*, a piece of silicon smaller than one's fingernail on which thousands of electronic elements are implanted. Called a *microprocessor*, it contains all the circuits one needs to carry out the many computer operations.

**CLOCK**

A device, inside the computer, that times events and keeps them coordinated. It also controls the rate at which information is processed, a rate sometimes measured in *nanoseconds* or *jiffys* (1/60 of a second).

**CODE**

The relationship between *bits* and a set of *characters*. Microcomputers deal only with bits when executing a *program*. Therefore, letters, numbers, and other human understandable characters must be translated into bits. Each character has a bit code representation. The most commonly used code is that known as *ASCII*. Code is sometimes used as a synonym for program. For example: one may say that a programmer generates code. SEE: BAUDOT CODE, BCD CODE.

**CODE LEVEL**

The number of *bits* used to represent a particular character. SEE: ASCII, BAUDOT CODE, BCD CODE, CODE.

**CODING**

Preparing a set of computer instructions.

**COMMAND**

An instruction given to the system through an *input* device or *peripheral*. It is executed as soon as it has been received. SEE: PROGRAM.

**COMPACTION**

Packing information to make more space in the *memory*.

**COMPATIBILITY**

There are two types of compatibility: *program* and *hardware*. Program compatibility refers to the ability to run programs on a variety of computers without changing the program *language*. Hardware compatibility means that various components (printers, discs, keyboards, etc.) may be connected directly without intervening electronic devices and that all components use the same *baud* rate, *word length*, and other technical aspects in order to communicate.

**COMPILER**

A program built into the system that lets the computer translate instructions written in a *high-level language*, understood by a human being, into a *machine-readable (object)* program, meaningful to the computer. SEE: ASSEMBLER, INTERPRETER.

**COMPILER LANGUAGE**

A computer language more easily understood by a human being than an assembly language. Compiler language instructs a compiler to translate a *source language* into a *machine language*. SEE: ASSEMBLER, COMPILER, INTERPRETER.

**COMPUTER**

A device that receives and then follows *instructions* to manipulate information. The set of instructions and the information on which the instructions operate are usually varied from one moment to another. If the instructions cannot be changed, the device is not a computer. The difference between a computer and a programmable calculator is that the computer can manipulate text *and* numbers; the calculator can manipulate only numbers. SEE: MICROPROCESSOR.

**COMPUTER LANGUAGE**

A language used to communicate with a computer. All computer language instructions must be translated by a program in the computer into the machine's internal language in order for the instruction to be implemented. SEE: ASSEMBLER, COMPILER, LANGUAGE.

**CONSOLE**

The operating portion of a unit. SEE: HARDWARE.

**CONTROL PANEL**

Type of *I/O* device which allows the user to communicate and *read* computer memory in *binary* form using switches on the front panel. SEE: HARDWARE.

**CONTROL UNIT**

Portion of a computer which directs the operation of the computer, interprets computer *instructions*, and initiates the proper signals to the other computer circuits to *execute* instructions. SEE: HARDWARE.

**COURSEWARE**

A combination of content, instructional design, and the *software* which causes a computer to implement instructions. SEE: FIRMWARE, SOFTWARE.

**CPS**  
Cycles Per Second.

**CPU**  
Central Processing Unit. The heart of the computer, controlling what the computer does. It includes three main sections: arithmetic, control, and logic elements. It performs computations and directs functions of the system.

**CROSS-ASSEMBLER**  
Program run on the computer to "translate" instructions into a form suitable for running on another computer. SEE: ASSEMBLER.

**CRT**  
Acronym for Cathode Ray Tube. Similar in appearance to a television screen. Information in the form of characters and *graphic* designs may be displayed on CRTs at the rate of 9,600 characters per second. A CRT terminal usually comes with a *keyboard* for entering information into the computer. SEE: VIDEO DISPLAY UNIT.

**CURSOR**  
Movable indicator on *CRT* to indicate a specific character or space that is being displayed. The cursor lets the user know where the next character to be typed will appear.

**CYLINDER**  
The *tracks* in a *disc*-storage system that can be recalled without having to move the access device.

**DAC**  
Digital to Analog Converter. SEE: A/D INTERFACE.

**DAISY WHEEL PRINTER**  
A printer which has a wheel mechanism, with characters on the perimeter of the wheel. The wheel rotates to place the appropriate character in print position. A "hammer" strikes the character, forcing it against a ribbon, thereby forming an impression on the paper. The daisy wheel printer has the reputation of great reliability, is relatively inexpensive, and forms a solid character on the paper. SEE: BELT PRINTER, INK JET PRINTER, MATRIX PRINTER.

**DATA**  
The information given to or received from a *computer*.

**DEBUG**  
Process of finding, locating, and correcting mistakes or errors in a *program* that might create problems or provide inaccurate information. SEE: BUG.

**DIAGNOSTIC ROUTINE**  
Test *program* used to detect and identify *hardware* malfunctions in the computer or its associated *I/O* equipment.

**DIGIT**  
Either a zero or one in the *binary number system*.

**DIGITAL COMPUTER**  
*CPU* that operates on specific data, performing arithmetic operations. Most computers store information in digital form, that is, as discrete units such as ones and zeros. SEE: A/D INTERFACE, BINARY SYSTEM, HEXADECIMAL SYSTEM, OCTAL SYSTEM.

**DIRECT MEMORY ACCESS (DMA)**  
A technique for rapidly moving data from the *micro-processor* to a *storage device* such as a *disc*. DMA is accomplished at the direction of a *program*. Not all microcomputers permit DMA.

**DISC (DISK)**  
A record-like magnetic-coated piece of material that can store programs, data, or tables of information. The process is similar to storing musical information on a magnetic tape. Commonly found are *floppy* and *hard disc* systems. SEE: HARDWARE, TRACK.

**DOCUMENT**  
A written description of a piece of *software* or *hardware*. It can also be used as a verb which is the process of producing such a description.

**DOS**  
Disc Operating System. A collection of *programs* which are the operating system (OS) for a *disc* drive. SEE: DISC, TRACK.

**DOT MATRIX**  
A method of generating characters by converting the ASCII code into a suitable group of dots arranged in a 5 x 7, 7 x 9, or other suitable patterned array. SEE: PRINTER.

**DRIVER**  
Small *program* which controls *peripheral* devices and their *interface* with the *CPU*.

**DUMP**  
Copying all or part of a *memory* onto another medium to retain the information yet clearing the memory for other activity.

**DUPLEX**  
Process of establishing two-way communication simultaneously between components of a computer.

**DYNAMIC MEMORY**  
A type of programmable *memory* which requires that the information on tiny capacitors inside *integrated circuits* be refreshed every so often to prevent the data from being lost. Generally uses less power and is cheaper and faster than static memory.

**EBCDIC CODE**  
Eight-bit code system: Extended Binary Code Decimal Interchange Code.

**ECHO CHECK**

Error control method in which message is returned to sender for verification.

**ECHO-PLEX**

Form of error control which displays information given to computer.

**EDITOR**

A program which allows changing, modification, or movement of programming statements. It allows the programmer to write and modify instructions using the *microprocessor* and a *terminal* as a very sophisticated typewriter. SEE: TEXT EDITOR.

**EPROM**

Electrically Programmable ROM. A read-only memory which can be erased either by an electrical signal or by ultraviolet light. SEE: RAM, ROM.

**ERROR**

Difference in value between actual response and desired response in the performance of a controlled machine, system, or process.

**ERROR TRANSMISSION**

Change in information caused during data transmission.

**EXECUTE**

The running of a computer program.

**EXECUTIVE CONTROL PROGRAM**

Main system *program* designed to establish priorities and to process and control other programs; also called a *monitor*.

**EXTERNAL STORAGE**

Auxiliary storage such as tape or disc. SEE: MEMORY.

**FAIL SOFT**

System for protecting data against loss in the event of system failure.

**FILE**

Collection of related data.

**FILENAME**

Number/letter characters that identify a file.

**FIRMWARE**

Programs which are permanently stored in *PROM* memory to allow easier understanding of the computer's operation. The programs are loaded in ROM (ROM or PROM). Firmware is often a fundamental part of the system's *hardware* design, as contrasted to *software*, which is not fundamental to the hardware operation. SEE: EPROM.

**FLOPPY DISC (DISK) DRIVE**

A device for storing masses of information on a rotating, flexible, metallic-coated plastic disc which is similar to a 45 rpm record. Information can be stored and retrieved

extremely fast. Unlike *cassette tape*, on which all information must be scanned, the disc allows the user to go to any area of the disc without searching through intermediate information. Floppy discs typically hold 256,000 bytes. SEE: TRACK.

**FLOWCHARTING**

A programming technique of using shaped blocks to indicate the sequence of operations in a *program*.

**FORTRAN**

Formula Translator. A science-oriented *high-level language*. SEE: ASSEMBLER, COMPILER.

**FREQUENCY**

Rate at which anything recurs. Usually measured in cycles or hertz per second.

**FULL DUPLEX**

Transmission and reception simultaneously. The telephone is a full duplex device. SEE: DUPLEX, HALF DUPLEX.

**GIGO**

Garbage in, garbage out. Implies that misinformation applied to the *CPU* will result in misinformation *output*.

**GRAPHICS**

Characters that can be used to form figures, shapes, and forms on the CRT or printer. In addition to letters and numbers, a computer may have a graphic *character set*, so arranged that they can be combined to form almost any desired figure. SEE: CHARACTER.

**HALF DUPLEX**

System of communication in which either transmission or reception can occur at a given time, but not both simultaneously. SEE: DUPLEX, FULL DUPLEX.

**HANDSHAKING OPERATION**

Interaction of the *central processor* and *interfaced* devices which requires the device to signal the processor as each command occurs during data transfer. This operation is performed by *modems* or *terminals* to verify that channels are cleared and that operations can proceed.

**HARDCOPY**

Data or information printed on paper. Used to distinguish between printed information and the temporary image found on the CRT. SEE: PRINTER, TERMINAL.

**HARDWARE**

Mechanical, magnetic, electrical, and electronic devices which make up a computer. The physical equipment that goes into a computer system, consisting of the *central processing unit* plus all *peripherals*.

**HARDWIRED**

Physically interconnected and usually intended for a specific purpose. Hardwired logic is essentially unalterable; a *microprocessor*, on the other hand, is program-

mable and may be adapted to accommodate various requirements.

#### HEAD

That part of a recorder that does the actual impression on the medium or reads that impression from a prerecorded medium.

#### HEXADECIMAL SYSTEM

A number system involving 16 characters, using numbers 0-9 and then letters A-F.

Decimal:	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hexadecimal:	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

#### HIGH-LEVEL LANGUAGE

A computer programming language using English words, decimal arithmetic, and common algebraic expressions. Each instruction represents a large number of computer operations. SEE: ASSEMBLER, BASIC, COMPILER, FORTRAN.

#### HOLLERITH

Coding system which uses combinations of 12 positions on a card to represent characters. SEE: CODE.

#### IC

*Integrated Circuit.* A plastic or ceramic body five cm long, two cm wide, and three mm thick with up to 40 leads extending from it. Inside the body is a *chip*. The body protects the *chip*, and the leads allow electrical connection of the chip to other components. The word "chip" is not to be used to refer to the entire IC.

ICs come in three sizes: SSI (Small Scale Integration—less than 20 gates); MSI (Medium Scale Integration 20-200 gates); and LSI (Large Scale Integration—over 200 gates). Microprocessors use LSI.

#### INK JET PRINTER

In an ink jet printer, a high-speed stream of electrically charged ink droplets are fired through a magnetic field. The field deflects the droplets to direct them to the proper location on the paper. This type of printer is relatively expensive but extremely fast. SEE: BELT PRINTER, DAISY WHEEL PRINTER, MATRIX PRINTER.

#### INPUT

Information going into the computer or into a peripheral. The same data may be *output* from one part of the computer and input to some other part of the computer. When using this word, specify what the data are input to or output from.

#### INSTRUCTION

A set of *bits*, or a command, which will cause a *computer* to perform certain prescribed operations. SEE: PROGRAM.

#### INSTRUCTION SET

List of commands to which a given computer responds. Instruction sets may vary among computers, even though those computers use the same programming language. SEE: PROGRAM.

#### INTELLIGENT TERMINAL

*Terminal* with built-in programmable intelligence enabling it to pre-process information and/or instructions without the aid of a *CPU*.

#### INTERACTIVE

System capable of two-way communication with a user during operation. A system is interactive if it responds to the user quickly—usually less than a second. All *personal computer* systems are interactive.

#### INTERFACE

An electronic circuit used to connect one electrical device to another electrical or mechanical device to allow the flow of data between units. It refers to the matching or interconnecting of systems or devices having different functions.

#### INTERNAL STORAGE

*Memory* system which is a part of the *computer*, as opposed to external *tape* or *disc* storage. SEE: RAM, ROM.

#### INTERPRETER

A program used to translate languages at the time of processing. SEE: ASSEMBLER, COMPILER.

#### I/O

*Input/Output* of information in a computer system. Examples of I/O devices are: a *keyboard*, a *floppy disc* drive, and a *printer*.

#### JOB

That part of a *program* defined as a task for the computer, complete with all *instructions*, *routines*, *data*, and *addresses*.

#### KEYBOARD

A device for typing information into a computer. It is similar in design and function to a typewriter keyboard. The computer keyboard has several additional keys for specific computer functions. SEE: CRT, PRINTER, TERMINAL.

#### K or KILO

Symbol or suffix for 1,000. In dealing with computers, 1 K is used to mean 1,024. A computer with 32 K *bytes* of memory means that it has 32 times 1,024 bytes of memory.

#### LANGUAGE

A format by which a programmer can communicate more efficiently with a computer where predetermined commands will yield requested actions. *BASIC* is one of the most popular languages.

A language is a defined group of representative characters or symbols, combined with specific rules necessary for their interpretation. The rules enable an *assembler* or *compiler* to translate the characters into forms (such as *digits*) meaningful to a machine, system, or a process. SEE: ASSEMBLER, BASIC, COMPUTER LANGUAGE, COMPILER, FORTRAN, HIGH-LEVEL LANGUAGE, INTERPRETER.

#### LIBRARY ROUTINES

Collection of standard *routines* that can be used in *programs*.

#### LINE FEED

The technique of a *teleprinter* that advances the paper one line at a time.

#### LOAD

Process of inserting information in *memory*. Opposite of "*dump*."

#### LSI

Large Scale Integration. Technique of making more complex integrated circuits. Refers to a component density of more than 200 transistor gates per chip. SEE: IC.

#### MACHINE LANGUAGE

A programming language whose instructions are written in *binary*, *octal*, or *hexadecimal* notation. Programs written in machine language do not need to be translated in order for the computer to execute the instructions. SEE: ASSEMBLER, ASSEMBLY LANGUAGE, COMPILER, INTERPRETER, LANGUAGE, PROGRAM.

#### MACROINSTRUCTION

An instruction which causes the computer to execute one or more other instructions. These "other instructions" are called *microinstructions*. SEE: INSTRUCTION.

#### MAGNETIC TAPE

SEE: TAPE.

#### MAIN MEMORY

That memory which is directly accessible to the computer. It contains the *operating system*, *programs*, and data being processed. In a microcomputer, main memory is referred to as *RAM* or *ROM*. SEE: MASS STORAGE.

#### MASS STORAGE

Devices such as *discs* or *tapes* are used to store large quantities of data. These devices are not directly accessible for processing by the computer, therefore the data which are stored must be read into *main memory* before the computer can use it. SEE: STORAGE CAPACITY.

#### MATRIX PRINTER

The matrix printer is so-called because it forms characters from a matrix of dots. Usually the matrix consists of five dots across and seven dots down or seven dots across

and nine dots down. The 5 x 7 matrix is suitable for upper case letters and numbers; however, for lower case letters and other characters, the resolution provided by the 7 x 9 matrix is better. Matrix printers have the advantage of being lower in cost than other types but are also slower in print rate. SEE: BELT PRINTER, CHARACTER, DAISY WHEEL PRINTER, INK JET PRINTER, PRINTER.

#### MEMORY

The *integrated circuits* of a computer which store information. In a microcomputer, these are referred to as *RAM* and *ROM*. SEE: IC, WRITE.

#### MEMORY CHIP

A *chip* which stores data in the form of electrical charges. SEE: MOS CHIP, RAM, ROM.

#### MICROCOMPUTER

A hardware configuration usually acquired in one of three ways: (1) by constructing several components from individual electronic parts (as in building a stereo system from a kit); (2) by connecting several already-constructed components (as in purchasing a separate amplifier, speaker, and turntable); or (3) by purchasing a unit with built-in components (as in buying a complete stereo system in one package, plugging it in, and using immediately). The end-product of the microcomputer is information. It records this information, processes it, puts it into meaningful terms, communicates it, stores it, and retrieves it when needed. It usually includes the microprocessing unit, a *keyboard* for entering data, a *cassette tape* recorder or a disc for storing programs, and a TV-like screen for displaying results. SEE: CPU, CRT, DISK.

#### MICROPROCESSOR

An *integrated circuit* that can execute *instructions*. It is one component of a *microcomputer*. It is the brains of the central processing unit (CPU).

#### MICROPROCESSOR BOARD

A board (actually made of plastic) to which are attached *integrated circuits*, including microprocessor *chips*, which form the *microprocessor*. SEE: IC.

#### MICROSECOND

One microsecond equals one millionth of a second. This is the speed at which some computers get and execute *instructions*. SEE: NANOSECOND.

#### MODEM

An abbreviation of the words "MODulator-DEModulator." It is a device which permits computers to transmit information over regular telephone lines. *Digital electronic signals*, generated by the computer, are converted by the MODEM into high and low tones. This process is known as "Modulation." The tones are a type of *analog signal*. The modem also converts analog signals to digital signals. SEE: HANDSHAKING OPERATION.

**MODULATOR**

An electronic device that allows a normal television set to be used as the *video display unit*. Frequently referred to as RF Modulator.

**MONITOR**

1. A *video display unit* which uses a *cathode ray tube* to generate characters. It looks much like a normal TV set; however, the monitor has a much higher degree of resolution, which permits a clear formation of very small characters on the screen. 2. A *program* which oversees the operation of other programs.

**MOS CHIP**

MOS is an acronym for *metal oxide semiconductor*. A MOS chip is a chip in *integrated circuit* (IC) which can perform a vast number of electrical operations. A MOS chip one-quarter of an inch square can perform operations equivalent to 6,000 discrete electronic devices. A chip this size has the power and ability of a room-sized computer of a few years ago. SEE: IC.

**MOTHER BOARD**

A *card* in a microcomputer with connections for various components and which is connected to the microprocessor. It forms the *interface* or connecting link between *memory* and *peripheral devices*.

**MSI**

An abbreviation for *Medium Scale Integration*. Refers to the quantity of circuit components, such as transistors, formed on a single circuit. SEE: IC.

**MULTI-PROCESSING**

Refers to more than one *microprocessor* executing different *programs* simultaneously. A computer system may contain more than one microprocessor, thus multi-processing may occur within that system.

**MULTI-PROGRAMMING**

A *microcomputer* can be multi-programmed if two or more *programs* are present in *main memory*. Because the microprocessor operates so rapidly, it appears that each program is *run* simultaneously.

**NANOSECOND**

One nanosecond equals one thousandth of one millionth of one second or  $1 \times 10^{-9}$  seconds. This is the speed at which many computers get and execute *instructions*. SEE: MICROSECOND.

**NOISE**

Refers to inaccurate data transmission. This causes typographical errors in *output*. SEE: BUG, DEBUG.

**NON-VOLATILE MEMORY**

A type of memory which maintains data without requiring *refresh*. *Tape* and *disc* are two media of non-volatile memory. Some types of *ROM* are also able to hold data and are frequently referred to as *static memory*. SEE: DYNAMIC MEMORY, VOLATILE MEMORY.

**OBJECT PROGRAM**

The form of a program which can be understood by a computer. The object program results from the translation of a human readable program, called *source program*, into a *machine language* program. An object program appears as a series of numbers when printed or displayed. SEE: ASSEMBLER, COMPILER, INTERPRETER.

**OCTAL SYSTEM**

Refers to a numbering system which has a base of eight compared to the decimal system which has a base of ten. Octal numbering is a compact means of representing *binary* numbers. The following illustration shows the relationship between octal and decimal numbers:

Decimal:	0	1	2	3	4	5	6	7	8	9	10
Octal:	0	1	2	3	4	5	6	7	10	11	12

Octal numbers are identified by a subscript  $11_{10} = 13_8$   
 $11$  (decimal) =  $13$  (Octal)

SEE: CODE, HEXADECIMAL.

**OFF-LINE**

Refers to data which are stored on devices not immediately accessible to the computer. Data stored on *magnetic tape*, *punched cards*, or *paper tape* must be loaded into *on-line* storage to be available to the computer.

**ON-LINE**

Refers to the location of data on storage devices which are immediately accessible to the computer. Usually on-line data are stored on *discs*, in *RAM*, or in *ROM*. Data which is *off-line* must be loaded into on-line storage for use.

**OPERATING SYSTEM (OS)**

A set of programs that are resident in a computer and facilitate using the attributes of the computer. An operating system typically controls the *I/O* functions such as managing the keyboard. A *disc operating system* is referred to as DOS.

**OS**

SEE: OPERATING SYSTEM.

**OUTPUT**

Information emanating from a display unit such as a *CRT* or printer. SEE: INPUT.

**PAPER TAPE**

SEE: TAPE.

**PARALLEL CONNECTION**

An electronic connector which allows the *microcomputer* to communicate with *peripheral devices* (*printers*, *keyboards*, etc.). A parallel connection transmits data in parallel mode, that is, all *bits* of information are sent simultaneously. If the microcomputer is sending in parallel mode then the peripheral device must receive in



parallel mode, and vice versa. SEE: SERIAL CONNECTION.

#### PARALLEL DATA TRANSMISSION

*Microcomputers* handle data in groups of eight or sometimes 16 *bits*. These groupings are called *words*. Parallel transmission refers to passing words from one component to another as an intact group. An eight-bit word would be transmitted as eight simultaneous bits along eight parallel wires. SEE: PARALLEL CONNECTION, SERIAL CONNECTION, UART.

#### PERIPHERAL DEVICE

A device, such as a *printer*, *mass storage* unit, or *keyboard*, which is an accessory to a *microprocessor* and which transfers information to and from the *microprocessor*.

#### PERSONAL COMPUTER

A *microcomputer* designed for use by an individual for entertainment, instruction, and bookkeeping chores.

#### PLOTTER

A *peripheral* device which draws two-dimensional shapes on paper. Some plotters also use colors.

#### PORT

The two most common types of ports are *RS232* and *20 ma* (read twenty millamps). These ports are frequently referred to as *I/O ports* (input/output ports) and are the connections through which the computer communicates with the outside world. Thus, ports are the "plugs" which connect the computer to *peripheral devices* such as *keyboards* and *printers*. SEE: PARALLEL CONNECTION, SERIAL CONNECTION.

#### PRINT MECHANISMS

SEE: BELT PRINTER, DAISY WHEEL PRINTER, INK JET PRINTER, MATRIX PRINTER.

#### PRINTER

A *peripheral* device which accepts *output* data from the *microprocessor* and prints characters on paper. Printers are defined as *impact* or *non-impact* depending on the means by which a character is formed on the paper. Impact printers strike the paper through a ribbon in a manner similar to a typewriter. Non-impact printers form characters by various means such as heat, electrical charges, or spraying ink. SEE: BELT PRINTER, DAISY WHEEL PRINTER, INK JET PRINTER, MATRIX PRINTER.

#### PROGRAM

A series of *instructions* to a *computer* which cause the computer to solve a problem or perform a task. SEE: ASSEMBLER, BASIC, COMPILER, EXECUTIVE CONTROL PROGRAM, FORTRAN, INTERPRETER, LANGUAGE, MACHINE LANGUAGE, ROUTINE, SUBROUTINE.

#### PROM

An acronym for *Programmable Read Only Memory*. A

type of permanent or *static memory* made of an *integrated circuit* which can be programmed after it has been manufactured. Programming a PROM consists of permanently recording data or instructions on the *chips* which make up the PROM. SEE: EPROM, RAM, ROM.

#### RAM

An acronym for *Random Access Memory*. Any *memory* which can be written on or read from by a *program* and in which the memory locations can be accessed in a random sequence. RAM can be erased and reprogrammed by the programmer as frequently as necessary. RAM size is expressed as a quantity of *bytes* such as 4K(4,000 bytes). RAM may be expanded by adding *memory chips* or *memory boards*. SEE: EPROM, PROM, ROM.

#### RANDOM ACCESS MEMORY

SEE: RAM.

#### READ

The act of retrieving data from *memory* or from an *input/output* device.

#### REFRESH

The process whereby *volatile memory* is constantly charged with electrical current. This keeps the *bit* pattern of the memory in proper order thereby maintaining the data which are *stored*. Without refresh, the memory would lose electrical charge, consequently losing the stored data. SEE: MEMORY, RAM, ROM.

#### REGISTER

A temporary *storage device* located in the *microprocessor* which can hold computer *bits* or words.

#### RESPONSE TIME

The interval of time required for the *microprocessor* to respond to an instruction or an input from a *peripheral* such as the *keyboard*. In an educational environment, the time interval from the activation of the keyboard to a display on the CRT should be less than three seconds.

#### REVERSE DISPLAY

Attribute of a *CRT* which permits characters to be displayed either as white on black background or black on white background. SEE: VIDEO DISPLAY UNIT.

#### RF MODULATOR

SEE: MODULATOR.

#### ROM

An acronym for *Read Only Memory*. It is made of an *integrated circuit* on which data or *instructions* are programmed at the time of manufacture. It cannot be erased or reprogrammed by computer operations. The size of ROM is expressed as the quantity of *bytes*, for example, 12K(12,000 bytes). SEE: EPROM, PROM, RAM, STORAGE CAPACITY.

#### ROUTINE

A series of instructions within a *program* which performs

a specific subtask of the program. A routine is usually performed only once during the execution of a program. SEE: SUBROUTINE.

## RS232

The name of a type of *port* which permits *serial transmission* of data to a *peripheral device*. The RS232 Interface has been standardized by the Electronics Industry Association and is found on many *microcomputers*.

## RUN

Jargon for *execute*.

## SCROLLING

A technique of displaying data on a *CRT* screen. Each line of data appears first at the bottom and moves upward as new lines are displayed. Eventually the line disappears off the top of the screen.

## SERIAL CONNECTION

An *input/output port* which allows *serial transmission* of data. In this serial transmission mode, each *bit* of information is sent individually. If a *peripheral device* receives in serial mode, then the microcomputer must send in serial mode, and vice versa. SEE: PARALLEL CONNECTION, SERIAL DATA TRANSMISSION.

## SERIAL DATA TRANSMISSION

A *means for transmitting computer words* by sending *bits* individually in sequence. Whereas in *parallel data transmission*, the bits are carried along parallel wires, in serial transmission only one wire is used; therefore, bits are sent and received singly. SEE: PARALLEL CONNECTION, PARALLEL DATA TRANSMISSION, SERIAL CONNECTION.

## SOFTWARE

Refers to *programs* and accompanying *documentation*. Software is stored on *tape* cassettes or *discs* when not being used by the computer. The computer *reads* the software into its *memory* in order to use the programs.

## SOURCE PROGRAM

A program written in a language such as *BASIC*, *FORTRAN*, or *COBOL*. The source program must be translated via a *compiler*, *interpreter*, or *assembler* into a *machine language object program*. The language of a source program is symbolic, that is, the instructions are represented by words or mnemonic devices which are readily understood by humans.

## STATIC MEMORY

A type of programmable *memory* which changes only when an electrical charge is applied. It is often found in a *MOS chip*. It does not require *refresh* operations as does *dynamic memory*. SEE: RAM, ROM.

## STORAGE CAPACITY

The quantity of *bytes* a *storage device* can hold. It is usually expressed in *kilobytes* which is abbreviated KB.

Thus, a disc is said to have a storage capacity of 400KB (400,000 bytes). This can be understood as 400,000 characters such as letters, numbers, spaces, etc. SEE: MAIN MEMORY, MASS STORAGE, MEMORY.

## STORAGE DEVICE

A *peripheral device* which holds information. This includes *tapes* and *discs*. SEE: WRITE.

## STORE

This term refers to the process of placing data onto some type of *storage device*. Usually the data are to be kept permanently; therefore, they are placed in a *non-volatile memory* such as a *tape*, *disc*, or *static memory ROM*. SEE: DYNAMIC MEMORY, VOLATILE MEMORY.

## SUBROUTINE

A portion of a *program* which performs a specific subtask. A subroutine is usually called upon several times during the execution of the program of which it is a member. SEE: ROUTINE.

## TAPE

There are two types of tapes used with microcomputers: (1) paper tape, and (2) magnetic tape. Each is a type of *storage device* which is often used for *mass storage*. Data are stored on paper tape by punching holes into the tape. A character is represented by a certain pattern of holes. n magnetic tape, patterns of electrical charges represent characters. SEE: MEMORY.

## TERMINAL

A *peripheral device* which facilitates human communication with a computer. Usually it consists of a *keyboard* with alphabetic and numeric characters coupled with a printing mechanism or a *CRT*. One enters information via the keyboard; the computer responds via the *printer* or *CRT*.

## TEXT EDITOR

A system of *programs* which facilitate editing. The functions available usually consist of adding text, deleting text, searching for specified text, paragraphing, and page layout. SEE: EDITOR.

## TRACK

The area of a *disc* on which magnetic pulses are recorded. These magnetic pulses are the electrical analog of *bits* or the information which is *stored*. A track is analogous to a groove on a music recording. Information is written onto a track and read off the track by means of a magnetic head in the same way a tone-arm "reads" a musical recording. Instead of a needle, the magnetic head has metallic pads that create (write) or sense (read) magnetic pulses. SEE: MEMORY, PERIPHERAL DEVICE, STORAGE CAPACITY.

## UART

Acronym for *Universal Asynchronous Receiver Transmitter*. This device converts *parallel data* transmission to *serial data* transmission, and vice versa. SEE: PARALLEL CONNECTION, SERIAL CONNECTION.

## VDU

Abbreviation for *Video Display Unit*.

## VERTICAL SCROLLING

A method of displaying text on a video display unit (VDU). In the case where more text is stored than can be displayed on a screen, the text is "scrolled," that is, moved up or down on the screen. When scrolled up, the text disappears off the top of the screen; when scrolled downward, the text rolls off the bottom.

## VIDEO DISPLAY UNIT

A component of a microcomputer system which displays the output on a screen similar to a TV screen. A television *monitor* is a type of video display unit. SEE: CRT (CATHODE RAY TUBE), MODULATOR.

## VIDEO MONITOR

SEE: VIDEO DISPLAY UNIT

## VOLATILE MEMORY

A *memory* device which does not retain information after electrical power is lost. *RAM* is a type of volatile memory. SEE: DYNAMIC MEMORY, REFRESH, ROM.

## WINDOW

Refers to partitioning a computer display into independent segments. A *CRT* screen may be divided into segments, one of which may contain explanatory text, another pictures or other graphic symbols, and the third segment representing questions pertaining to the text and pictures. The fourth segment could present responses to the student's answers to the questions. The contents of each segment or window could be varied independently of any other window.

## WORD

A grouping of *bits*. Words may consist of eight bits or 16 bits. Computers read, store, and manipulate data in words rather than as individual bits. SEE: WORD LENGTH.

## WORD LENGTH

The number of *bits* in a *word*. Most microcomputers have a word length of eight bits, though a 16-bit word length is also available from some manufacturers. SEE: WORD.

## WRITE

The act of delivering information to a *memory* device or a *storage* medium. SEE: READ.

APPENDIX B  
LETTER OF TRANSMITTAL

LETTER OF TRANSMITTAL  
(METRO WINNIPEG HIGH SCHOOL PRINCIPALS)

Dear Colleague:

I am a teacher who is presently in the midst of an M.Ed. thesis and I would appreciate a few minutes of your time.

Since my study centres around the use of microcomputers for school administration, I am initially attempting to locate microcomputing schools. You could help me by filling in the enclosed questionnaire and returning it to me in the stamped envelope. Please feel free to designate someone else on your staff to fill in the questionnaire if you wish.

Thank you for your assistance.

Sincerely,

Vern Barrett

Encl.

APPENDIX C  
QUESTIONNAIRE

QUESTIONNAIRE  
(METRO WINNIPEG HIGH SCHOOL PRINCIPALS)

QUESTIONNAIRE ON MICROCOMPUTER USE

NAME OF SCHOOL \_\_\_\_\_

NAME OF PERSON RESPONDING \_\_\_\_\_

1. DO YOU HAVE A MICROCOMPUTER IN YOUR SCHOOL?      YES      NO

2. IF "YES" IS THE MICROCOMPUTER USED FOR:

\_\_\_\_\_ Teaching Computer Courses

\_\_\_\_\_ Computer Assisted Instruction in Other Subjects

\_\_\_\_\_ Administrative Use

\_\_\_\_\_ Other (please specify)

3. IF THERE IS PRESENTLY NO MICROCOMPUTER IN YOUR SCHOOL ARE THERE PLANS TO PURCHASE ONE? \_\_\_\_\_ IF SO, FOR WHAT PURPOSE? .

Thank you for your assistance -- I really appreciate your efforts.

Sincerely,

Vern Barrett

APPENDIX D  
INTERVIEW SCHEDULE



INTERVIEW SCHEDULE

1. How did your school get involved in the use of microcomputers for administrative functions?
2. Which microcomputer is your school using?
3. How long has your school used the microcomputer for administrative functions?
4. What was the cost of the unit?
5. How was it paid for?
6. Who owns it?
7. Which administrative functions does it perform?
8. How many records does it deal with?
9. How often are the microcomputer files updated?
10. How accessible is data when needed?
11. Who operates the microcomputer?
12. How are operating staff trained in its use?
13. Has the introduction of the microcomputer at your school resulted in any change in the number of clerical staff?
14. How reliable is your microcomputer?
15. Are any security measures taken or needed to protect files from tampering?
16. Are duplicate records kept on paper?
17. What has staff/student reaction been to its use?
18. Have you experienced any difficulties other than those previously mentioned as a result of microcomputer use at your school?
19. Is the microcomputer used for purposes other than administration in your school?
20. What plans are there to expand or decrease its use in your school?

APPENDIX E  
SEVEN OAKS DUTIES OF PRINCIPALS

## DUTIES OF PRINCIPALS

## Core Function

The principal shall be responsible for establishing and maintaining conditions conducive to learning and teaching.

## Details of Functions

## A. Educational Leadership Functions

## 1. Program Implementation

- shall create an environment that is conducive for the staff individually and collectively to pursue the development of programs that best meet the interests and needs of students.
- shall be responsible for initiating procedures for program evaluation.
- shall be responsible for coordinating the programs within the school into a total functional operation.

## 2. Staffing

- shall be responsible, in cooperation with the Superintendents' Department, for the hiring and placement of personnel on the staff, and for recommending dismissal to the Superintendents' Department.
- shall evaluate the effectiveness of each member of the staff in accordance with the plan contained in this Policy Manual, and shall forward such reports, after signature by the teacher concerned, to the Superintendents' Department.
- shall be responsible for cooperating with the Faculties of Education in providing their students with beneficial teacher training experiences.

## 3. Communicating

- shall involve staff in decision-making.
- shall keep the Superintendents' Department fully advised as to the conditions and needs of the school, and shall submit reports as required.

### 3. Communicating (Cont'd.)

- shall be responsible for developing procedures within the school that facilitate "open" communication between the school and the home.
- shall keep the people within the school community informed about the school and its activities.
- shall hold staff meetings as necessary for the purpose of discussing educational and administrative matters.
- shall be responsible for maintaining liaison with personnel providing specialized professional services in the school division, (e.g. Child Guidance Clinic, Community Schools.)

### 4. Professional Development

- shall display leadership and assist in the individual and collective professional development of the staff.
- shall personally undertake professional growth activities.
- shall assist in the identification of desirable professional growth activities for participation by all administrators and supervisors in the School Division.

### 5. Student Concerns

- shall be responsible for providing a climate in which students can develop self-discipline.
- shall involve students in certain decision-making activities in the school.

## B. Administrative Functions

### 1. Student Administration

- shall be responsible for the registration of pupils and for the maintenance of up-to-date cumulative records as specified by the Superintendents' Department.
- shall be responsible for the organization of the supervision of pupil activities in the school building, on the school grounds, from prior to school opening to immediately after school dismissal.

### 1. Student Administration (Cont'd.)

- shall authorize, and shall be responsible for the supervision of, activities sponsored and conducted by the student organizations of the school.
- shall be responsible for the organization of school patrols according to the regulations contained in this Policy Manual.

### 2. Finance Administration

- shall prepare the school's annual operating and capital budgets within the bounds established by the Superintendents' Department and shall supervise the ongoing expenditures under the school's control.
- shall be responsible for the administration of a system of accounting for all school monies, and shall submit all books to the Secretary-Treasurer for an annual audit.

### 3. Facilities

- shall be responsible for taking all reasonable precautions to safeguard the health and safety of staff and pupils.
- shall be responsible for inspecting the condition of school property and for reporting instances of vandalism and break-ins to the Superintendent and the Director of Maintenance. Where damage is serious and appears to have been deliberate, it shall be reported to the Police Department, or other appropriate action shall be taken.

### 4. Personnel Administration

- shall be responsible in cooperation with the Custodial Supervisor for the direction of the work of custodial staff in the school.
- shall be responsible for the direction of the work of the clerical staff, teacher aides and volunteers in the school.

### 5. Policy Manual

- shall be responsible for implementing all policies within the Policy Manual that are related to the students and staff within the school.

5. Policy Manual (Cont'd.)

- shall be responsible for seeing that copies of this Policy Manual in the school are kept up-to-date.
- shall be responsible for maintaining an awareness of Board policy within the school.

Other Provisions

The duties of principals are subject to the provisions of Provincial Statutes related to education and to Section 43 of the Criminal Code of Canada, as attached.

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