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# MicroComputer and Local Government

Donald F. Norris
*University of Nebraska at Omaha*

Norris

MICROCOMPUTERS AND LOCAL GOVERNMENT

by

Donald F. Norris

Contents

# PREFACE

By the time this book is printed some of its contents will be out-of-date. Obsolescence quickly overcomes anything written about **technical** aspects of microcomputing, such as memory and storage capacities, processing speed, operating system capabilities, communication, and peripherals. About the best an author can do is to report accurately on the technology that is available at the time a manuscript is completed and to acknowledge that change is the great constant in the world of microcomputers. Micros that enter the marketplace next year, or even next week, undoubtedly will be smaller, more powerful, and less expensive relative to their processing power.

The nontechnical, or **management** aspects of this book, however, possess a greater timelessness. This is not to say that management concepts and practices remain unchanged over time, rather, they change more slowly. In particular, the concept that microcomputers should be used to provide information for management purposes is as valid today as when it was first written. Based on what I have observed in my research, the procurement guidelines provided in this book are also valid and are likely to remain so for some time to come.

What is new about this edition compared with the handbook written in 1984?* The chapter on hardware has been updated, as of spring 1986. The chapter on software has been expanded considerably to incorporate changes that have occurred in the industry during the past two years, to provide brief explanations of the types of software available, to show how off-the-shelf software and packaged programming can be useful to local governments, and to

*Donald F. Norris, Microcomputers and Local Government: A Handbook (Omaha, NE: Center for Applied Urban Research, University of Nebraska at Omaha, 1984).

provide some guidance on what to look for in a good software package. The chapter on issues has been revised somewhat and expanded to address the issues of computerphobia, user frustration, and physical complaints associated with computer use.

Two new chapters have been added. Chapter V addresses data communication--among micros, micros to larger systems, micros to external databases, local area networks, and hardware and software requirements for communication. Chapter ~~VII~~ VIII addresses the effects of microcomputers on work, people, and governmental organizations and is based on recent field research conducted by the author and others.

The final change is that documents that were included in the Appendix of the original handbook have been modified, updated, and included in the chapters of this text (for example, specifications for microcomputers), or they have been deleted because of limited shelf-life (for example, the table of microcomputer hardware) or because publication is being undertaken separately (for example, the list of microcomputer software).

Unlike the original handbook, this volume is not designed specifically for use in training workshops, although it could be so employed. Rather, it is a stand-alone book for governmental employees, especially managers who have limited knowledge about microcomputers but who are responsible for acquiring, implementing, and using microcomputers or who just want to make sense out of the organization's information management activities and technologies. The information presented on the following pages should help readers navigate safely the sometimes choppy waters of computing and information management.

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Revision of the handbook I developed in 1984, into the present volume would not have been possible without the assistance of several persons and organizations. Particular thanks go to the W. K. Kellogg Foundation and Dr. Gary W. King, project director, for the financial support that enabled me to write the original handbook and to revise, expand, and update it for publication in this volume. Indeed, this book is only one aspect of a much broader project to provide training and technical assistance in microcomputers to bolster management within local governments that was made possible by generous support from the W. K. Kellogg Foundation.

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Mr. Don Borut
International City Management Association

Mr. Michael Carpenter
Management Information Systems Director
City of Omaha, Nebraska

Dr. David R. DiMartino
Center for Applied Urban Research
University of Nebraska at Omaha

Dr. Donald B. Erickson
Department of Economics
Kansas State University

Mr. Jeff Fletcher
National League of Cities

Dr. Alvin House
Department of Agricultural Economics
Michigan State University

Mr. Dennis Kouba
International City Management Association

Dr. Theodore J. Maher
U.S. Department of Agriculture

Mr. Michael T. Pentecost
Municipal Technical Advisory Service
University of Tennessee

Ms. Olivia Kredel Pickett
National League of Cities

Dr. B. J. Reed
Public Administration Department
University of Nebraska at Omaha

Mr. Douglas Robinson
NASA/UK Technical Assistance Program
University of Kentucky

Mr. Robert Sellers
Institute of Government
University of Georgia

Mr. Jeffrey Schiff
National Association of Towns and Townships

Dr. Costis Toregas
Public Technology, Inc.

Dr. Jack Whitmer
Extension Political Scientist
Iowa State University

# CHAPTER I -- INTRODUCTION

In 1976, two young Californians named Steve Jobs and Steve Wozniak started a revolution. It was a quiet revolution...no shots were fired...no demonstrations occurred...there were no casualties, but it was a revolution nevertheless...a revolution that will have long-lasting results. That year these two young men developed the Apple, the first commercially successful microcomputer.[1]

Between the development of the world's first computer in 1946, and the introduction of the Apple, about 500,000 computers of all kinds were installed. Between 1976 and 1986, over 20 million microcomputers were sold, 40 times the number of larger computers that had sold in the first 30 years of electronic computing--and sales continue to grow.[2] In the first quarter of 1986 alone, for example, many microcomputers were purchased by federal agencies--90,000 by the military and 8,000 by the Internal Revenue Service.[3]

Microcomputers, also known as **personal computers**, are affecting the ways in which people and organizations do their work. Most importantly, they have brought computing or data processing to a personal level. That is, for a few hundred to several thousand dollars, persons who are not programmers, systems analysts, or technicians can acquire computer systems that can easily perform a range of tasks more rapidly, more accurately, more efficiently, and at less cost than any other available technology.

Micros offer numerous potential benefits to their users. However, sales remain ahead of the general public's knowledge of these machines and how to acquire and use them effectively. This is especially true among America's local governments. Yet, data from recent studies indicate that many local governments will purchase micros in the next few years. For example, a study undertaken by the International City Management Association in 1982, showed that 13 percent of city governments had microcomputers and that 35 percent planned to buy one or more micros in the next two years.[4] A similar study conducted in 1985, found that at least 75 percent of the cities surveyed owned micros. This represented almost a sixfold increase over the number of cities with micros in 1982, and an adoption rate nearly twice that suggested by purchase plans reported in the earlier survey.[5]

Although the benefits of microcomputers appear to outweight their liabilities, research suggests that experiences with them are not universally satisfactory. Inappropriate hardware and software are purchased; machines break down; users are not trained and supported adequately; computerphobia and increased job stress occur; and unnecessary duplication of effort takes place.

**Microcomputers and Local Governments**

A great deal of information exists about microcomputers. Much of it is sales literature aimed at persuading people to purchase microcomputers. Other material is written by vendors, consultants, and reporters for the popular media.

Information from the popular media and microcomputer advertising tends to emphasize four themes: (1) **micros are inexpensive**--almost anyone can afford one, (2) **micro sales are growing rapidly**--almost everybody has one, (3) **micros are easy to use**--almost anybody can use one, and (4) **micros have tremendous capabilities**--almost anybody can do almost anything with one. Whether watching television, waiting in a dentist's office, riding in an airplane, or just reading the daily newspaper, people are bombarded with information about micros. The message is that without a micro in the office or at home, we will not be able to manage our work effectively and our children will not do well in school. Of course, this is nonsense, but nonsense that is repeated frequently enough can have an impact on potential microcomputer buyers. Unfortunately, very little of this material is based on research about the acquisition and use of microcomputers. Instead, it is based on opinion, speculation, superficial observation, and sales hype.

A second, although somewhat smaller, body of literature on computers and computing has also emerged in recent years. This literature is a type of high-tech Ludditism and it ascribes significant negative effects to computing. Witness the following: "The ~~recent~~ birth of the new civilization in the Silicon Valley heralds an end to romantic love as it has been known in Western civilization."[6] A statement such as this is as nonsensical as one that attributes nearly magical problem-solving abilities to microcomputers.

Very little data, based on systematic research into the uses and effects of microcomputers, are available to guide potential purchasers. According to one respected source: "Few topics exist on which so much has been written recently yet for which so little empirical research has been conducted."[7]

Research that provides some clues regarding the uses and effects of microcomputers in local government is beginning to emerge. Findings from that research will be presented throughout this volume, especially in the chapters on software, procurement, and effects. Hopefully, these findings will dispel some of the myths and excessive claims surrounding microcomputers.

We can begin by stating the following basic facts about microcomputers in local government:

- Local governments are buying them in record numbers;
- Micros are being used in almost every local government department and for a variety of activities;

- o Micros are used primarily in word processing, spreadsheet, and database management applications, followed by applications employing packaged or custom-written software;
- o Local governments use several types of hardware, but IBM and IBM-compatible devices predominate;
- o Most micros are stand-alone machines that do not communicate with other systems;
- o Micros are viewed as instruments or tools by their users, that is, they are used as tools to accomplish work;
- o Both positive and negative effects occur with the use of microcomputers, but positive effects predominate;
- o Most microcomputer users are satisfied with their systems, even though they also report frustrating aspects of microcomputer use; and
- o Most cities plan to buy more microcomputers in the near future.

**Purposes of This Book**

The history of the use of computer technology by local governemnts is filled with examples of both successes and failures. The successes show that computers can be used effectively and efficiently, provide valuable information for management purposes, and do the work of scores of people. Indeed, many local governments would find doing without their computers impossible and would find the cost of replacing computer-performed functions with personnel prohibitive. The failures of computer systems in local governments include systems that were too costly, failed to perform up to reasonable expectations, had hardware inadequacies, and experienced software failures.

A question confronting many local governments today is how to ensure that the acquisition and use of microcomputers will be successful. This book has been written to help answer this question by providing the following:

- An overview of computers, data processing, and information management;
- An introduction to microcomputers, their uses in governmental organizations, and their positive and negative effects;
- An identification and examination of key issues associated with microcomputer acquisition and use; and
- A set of procurement guidelines for local governments that plan to acquire microcomputer systems.

Several things should be borne in mind about this book. It is written so that readers who have little knowledge of micros and their uses can understand it. It should also be informative for persons who are familiar with microcomputers, particularly the discussion of recent research findings on the effects of micros.

This book is **not a technical one**, so persons with technical backgrounds and extensive experience in computers and data processing may be disappointed. It does not address issues such as chip technology, internal system architecture, how to write programs, and other essentially technical issues. Instead, its principal focus is to simplify an otherwise complex and often incomprehensible subject so that governmental officials and potential users who are not technical experts will become more knowledgeable about how to acquire and use microcomputers.

This book will not make readers instant experts. It will provide useful information about a difficult subject, provide a key to the jargon or specialized language associated with computer technology, and address many management issues concerning computer use in government. Interested readers should seek additional information about microcomputers from other sources, such as books and periodicals, other government offices, and sales outlets. Potential users are urged to ask questions, to examine systems, and to sit down at the terminals of various microcomputers to try out programs.

## CHAPTER II -- DATA PROCESSING AND INFORMATION MANAGEMENT

All local government personnel, especially those in management positions, are regularly involved in data processing whether or not they know it. This is true for users of manual systems as well as for those who use computers.

In governmental organizations, information is a valuable resource. Information enables us to know, for example, whether organizational performance meets predetermined goals and objectives. But, information does not simply occur. It must be developed. The basic ingredient in information is something called **data**, diverse facts available to an organization. These diverse facts might include mundane details such as the number of hours worked by employees and the number of hours of sick and vacation leave taken in a pay period.

The first step in developing information requires the processing of data. This can be done using pad, pencil, and calculator, or it can be done using computers. **Data processing** is the collection, compilation, and manipulation of diverse facts available to an organization to produce information. **Information** is different from data because information is a coherent, organized body of material that provides users with knowledge about an event, activity, or phenomenon.

What does this really mean? Whenever data and information are discussed, an old comedy routine about partial sports scores comes to mind.[8] A partial score might read as follows: Lions 17 or 17 to 14. Partial scores are data. They are diverse facts lacking coherence and organization, and they make no sense. Information, on the other hand, makes sense. A complete sports score might read Lions 17 - Packers 14. Here, data have been manipulated and presented in an organized, coherent, and useful fashion. As one source puts it, the distinction between data and information can be summarized "by a single word: Usefulness. No amount of data can be called information until it has been assembled together or processed in such a way as to make it useful to someone. Its usefulness must be determined by the user..."[9]

Complete, accurate information will enable governmental managers and decisionmakers to make sound decisions regarding their organizations and activities. The **purpose of data processing**, especially automated data processing, should be to provide complete, accurate, and reliable information for management purposes. However, organizations use data processing systems for reasons other than providing information for management purposes, such as cutting costs, improving efficiency, reducing or holding down the number of personnel, accomplishing tasks efficiently, and peer pressure.

**Management purposes** refer to anything that local government decisionmakers and managers decide they need to know to do their jobs. Department heads may want to know about absenteeism among their employees. What is the average rate? Which employees are chronically late for work? Who is regularly absent on Mondays or Fridays? A street superintendent may want to know how much it costs to pave a mile of street, install curbs and gutters, or operate a fleet of vehicles. The police department may want to know not only the number and types of crimes reported but also the time and location of occurrance. This is information for management purposes because in each case decisions can be made and actions can be taken to improve performance. Without solid information, decisions and actions are less rational, more haphazard, and have greater potential for being incorrect.

For routine data processing activities, such as processing payroll checks or water bills, the first goal of management is often to improve methods of performing repetitive tasks on voluminous data. Only secondarily does management consider producing information for decisonmaking purposes. Yet, even in these routine areas, data processing produces valuable information.

An automated payroll system should ensure that customers are paid correctly and on time. It should also provide managers with information about total payroll costs; payroll by department, function, project, and class of employee; absenteeism rates; and fringe benefit costs. Likewise, an automated water billing system should not only ensure that customers are billed on time, it should also furnish information on volume of water used by class of customer, increases or decreases in total water use, seasonal variations, and percent of customers with overdue bills. These are just a few examples of information that should be made available to local government managers from two relatively routine data processing activities. What is true of these activities, of course, is also true of others--**data processing should provide useful information for management purposes.**

**Uses of Information**

Information can be used in many ways and for different purposes. The nature and purpose of the information vary with the type of organization. A sales organization will be interested in things such as inventory control, sales figures, gross receipts, and net profits. A physician will want to have accurate patient records and also be able to calculate patient bills. A school system must maintain student records and schedule classes, and so on.

Two fundamental types of information management, regardless of organization, are **housekeeping activities** and **decisionmaking activities.** Housekeeping activities include a variety of mundane, everyday functions that nearly all organizations perform.

Figure II-1
HOUSEKEEPING ACTIVITIES

- Budgetary accounting
- General ledger accounting
- Accounts payable
- Cash management and accounts receivable
- Payroll
- Personnel management
- Utility billing and accounting
- Tax billing and collection
- Departmental recordkeeping
- Word processing

With the exception of word processing and certain aspects of departmental recordkeeping and personnel management, housekeeping activities are mainly concerned with financial management or preparing and controlling the flow of funds to, within, and from a governmental organization. Small governments and smaller subunits within larger governments may perform these functions without computerization, but almost all larger governments use computers.

Decisionmaking activities are significantly different from housekeeping activities. The former may use much of the same information as the latter but their purpose is different. The purpose of budgetary accounting, a routine housekeeping activity, is to produce information about actual revenues and expenditures in relation to their budgeted (or projected) occurrence and in relation to the previous year's actual occurrence.

Figure II-2
DECISIONMAKING ACTIVITIES

- Spreadsheet programs
- Database management
- Decision support

Budget preparation, on the other hand, is a decisionmaking activity. Persons involved in the budgetary process will use data from the budgetary accounting system but will not stop there. Their principal objective is to project future budgetary conditions. To do so, these persons will ask hypothetical or "what if" questions about future revenues and expenditures. Whereas the purpose of budgetary accounting is essentially to keep track of current financial conditions, budget preparation attempts to provide information so that policymakers can decide what to do in planning for the next budget cycle.

In the world of microcomputers, **spreadsheet** programs (such as Lotus 1-2-3, Multiplan, and others) enable local government personnel to prepare their budgets by asking questions such as: What will happen if all personnel receive a 5-percent raise? What if the cost of fringe benefits increases by 10 percent? What if tax revenues decline by 1 percent? Spreadsheet programs allow managers to receive immediate answers to the effects of these what if conditions. Armed with this information, decisionmakers can plan more knowledgeably for the coming year's budget.

Another example of microcomputers being used for decisionmaking is database management. Two examples of database management programs are dBASE II and R:Base 5000. They enable local governmental personnel to use standard English-like commands to create files and records on the computer rather than on paper, to sort through records on a system, to produce unique reports, and to combine data from separate files. Many database management programs also allow users to combine information from the database with spreadsheet data and narrative produced with a word processor to complete reports. Database management programs can also be used to create relatively sophisticated applications programs, such as incident recordkeeping and reporting systems for small police departments.

Database programs can simplify activities and promote greater efficiency. Reflect, for a moment, on the difficulty of sorting manually through personnel records to complete federally required equal employment opportunity reports. In one medium-size city, these reports were prepared each year by a personnel technician who manually reviewed more than 2,500 personnel files to extract the required information. A database management program can change this from a major task to a relatively short and simple exercise.

Database management programs can simplify other activities by providing information quickly and in a form desired by managers. Like spreadsheet programs, they provide information for decisionmaking purposes. Even though housekeeping activities far outweigh decisionmaking activities in current local governmental use of computers, the most sophisticated use of microcomputers may well be to aid in decisionmaking.

**Evolution of Computer Technology**

The world's first electronic computer, which became operational in 1946, was called ENIAC--Electrical **N**umerical **I**ntegrator **A**nd **C**alculator. It was a huge machine, containing thousands of vacuum tubes. Weighing 30 tons and hard-wired for up to 6,000 individual switches, ENIAC was kept in a large, environmentally controlled room. It operated at a speed in the millisecond range (1/1000th of a second) which, while slow by today's standards, was considerably faster than most people can balance their checkbooks.[10]

In the span of a single generation, computer technology has gone through four distinct developmental stages or technological generations. **First generation vacuum tubes** were replaced in the late 1950s by **second generation transistors.** The **third generation** was born in the mid-1960s when solid logic technology reduced the electronic innards of the computer to silicon chips, and **integrated circuits** replaced transistors.

The **fourth generation** of computer technology followed rapidly on the heels of the third and is based on what is called **VLSI** or **V**ery **L**arge **S**cale **I**ntegration. Using sophisticated photo-etching techniques, circuits containing the equivalent of tens of thousands of transistors can be placed on a silicon wafer the size of a fingernail. This has also made possible the latest revolution in computer technology--the microprocessor or computer on a chip.

With each new generation, computers have become faster, smaller, less expensive, more reliable, and easier to use. Hence, computer technology is one of the few areas of the economy where price has actually declined in relation to capability in the past three decades. This phenomenon has led, in part, to the increasing adoption and use of computers.

The state-of-the-art in commercially available computers is equipment or hardware based on VLSI. These can be either mainframes, minicomputers, or microcomputers. Their internal speed is currently in the nano- or pico-second range (one-billionth or one-trillionth of a second), and they can be accessed by an operator through a standard cathode ray tube (CRT) or computer monitor. Prices for state-of-the-art equipment range from a few hundred dollars for microcomputers to several million dollars for supercomputers.

**Functions of a Computer**

A computer is an electronic device capable of performing four basic functions:

- **Input**--Placing data into the system, usually via a keyboard but sometimes using electronic and magnetic means (disk, tape, optical scanner, voice recognition, and computer to computer);
- **Processing**--Manipulation of data, usually by executing computer programs or software which instruct the computer in the exact procedures to follow with the data;
- **Storage**--Maintenance of data, usually keeping data on magnetic media, such as disks and tapes; and
- **Output**--Retrieval of data and information, usually getting information that has been processed or stored to appear on a video monitor or to be printed.

These functions are performed using electronic and magnetic media or devices such as computer terminals, disk drives, and printers. The use of these devices often gives rise to confusion and apprehension. However, information management on a computer is conceptually no different from using a pencil and paper, a calculator, and a file cabinet.

Figure II-3 shows information management using the basic technology available to most organizations for their daily activities without using a computer.[11] The data **input** function is analogous to the in basket sitting on a desk. This is where data, in the form of diverse facts and figures, arrive for consideration and action.

**Processing** occurs using a pencil and paper, a calculator, and a human brain. In this function, the data are converted to information. An example might be a clerk or manager receiving overtime reports from various departments. These reports contain data. Manipulation or processing of these data will produce documents reporting on overtime use by department, project, and program and will allow analysis of overtime against the current year's budget and in comparison to last year's budget. Many organizations would find this type of information valuable because it can be used to maximize organizational efficiency. Data processing, whether manual or automated, is required to produce information from raw data.

Data and information **storage** in this system is handled in manila file folders that are kept in vertical filing cabinets.

**Output** is the placing of a printed or typed report in the out basket. The report is delivered to other persons in the organization and used by them.

The major differences between information management using the basic technology shown in Figure II-3 and using an electronic computer are the following:

- **Speed**--Computers are thousands of times faster than manual systems. However, they can also compound errors more rapidly than manual methods.

- **Accuracy**--Computers calculate with a high degree of precision and are extremely retentive. They do not forget unless they are told to do so. Unfortunately, they will act on bad as well as good programming and data.

- **Efficiency**--Computers can perform the work of several people--even tens or hundreds. Therefore, they can be used to replace people or to extend the capabilities of current staff.

- **Equipment**--Instead of in and out baskets, vertical files, and calculators, data processing on a computer uses CRTs, CPUs, disk drives, printers, and other esoteric devices.

- **Complexity**--Owing to the technology itself, even simple computer systems are far more complex than manual systems. Among other things, good backup and restoration procedures are needed in case the system fails. As more than one management information system (MIS) director has said, having a microcomputer means having a data processing system with all of its attendant problems.

Knowing what computers are not is also important. **They are not panaceas** for the ills of local governmental management. Computerization is no substitute for good management. In fact, using a computer to circumvent bad management practices can make the results of those practices even worse because the computer will also act on bad data and bad programs, thereby complicating the problem.

Computers can provide extremely fast, accurate, and reliable processing, storage, and retrieval of data. They are especially good for work that is repetitive and involves large amounts of data. However, computers cannot make decisions. All they can do is provide organized information to persons who then must make the decisions. The information that computers can provide is also limited by the data and software that are on the system.

Having a computer, even one that provides good information, does not guarantee that management decisions will be good ones. Human beings, no matter who they are or where they are employed, have the ability to take perfectly good information and make perfectly awful decisions.

# CHAPTER III -- MICROCOMPUTER HARDWARE

This chapter is somewhat more **technical** in nature than the rest of the book. However, it has been written to simplify and demystify computer technology and terminology and, at the same time, to present the principal technical concepts and components required for a basic understanding of a computer system.

Readers will not be able to design or build a computer or to write programming after reading this chapter, but they should come away with a sound grasp of the main elements of a computer system and how it works. Such an understanding is essential for officials and staff in local governments that intend to acquire and use microcomputers.

## The Computer System

Typically, one of the first questions asked when an organization decides to acquire a microcomputer is, "Which micro should we buy?"

Ask computer vendors or salespersons, and the answer will very likely be machines from their companies. Software vendors will recommend computers on which their programming runs. By and large, however, the brand of microcomputer matters very little. Most hardware on the market today is highly reliable, and when breakdowns occur they can usually be repaired quickly, inexpensively, and satisfactorily.

What matters when buying a microcomputer is that the **system** is capable of performing all of the functions that require automation and that it does so at a predetermined level of effectiveness. The term **computer system** means **the hardware, software, and all other equipment and programming necessary for the computer to perform required tasks.** This means that everything is present that will enable local governmental personnel to make a payroll, perform budgetary accounting, print utility bills, or perform other predetermined functions.

A microcomputer system consists of two basic elements. These are **hardware**, including a central processing unit (or CPU); mass storage devices, usually magnetic disk or tape; video display monitors; printers; modems; and possibly other peripheral devices; and **software** or **programming**, including operating systems and application programs.

**Memory and Processing Power**

The microcomputer gets its name from its principal hardware component: **the microprocessor.** The first microprocessor was developed in 1971, by Dr. Ted Hoff at the Intel Corporation in California. Intel remains a major supplier of microprocessors. Five years later, owing to dramatic increases in microprocessor capacity, the microcomputer industry was born.

A microprocessor is a large-scale integrated circuit containing the basic components of a computer. Microprocessors have been miniaturized and photo-etched onto a wafer of silicon about the size of a thumbnail. This wafer or chip contains tens of thousands of miniature electrical switches or gates that enable it to hold, read, and process data.

Data are represented in a microcomputer as bits. The word **bit** stands for **binary digit**, and symbolizes what enables the computer to function--the binary property of electricity--it is either on or off. Computers read bits of data by their electrical character, whether current is off or on at a switch or gate.

Eight bits are combined in computers to form a **byte.** A byte, a combination of eight bits in on-or-off positions, is used to represent a letter, number, or symbol. Hence, a byte is a **character.** Characters are determined according to the arrangement of bits in a byte. For example, the number one (1) is represented in one common eight-bit coding scheme as:

ON

ON

ON

ON

OFF

OFF

OFF

ON.

The number two (2) looks like this:

ON

ON

ON

ON

OFF

OFF

OFF

ON

OFF.

Remember: a **byte** is a character--a number, letter, or symbol. A byte commonly contains **eight bits**; a bit is a **binary digit** representing one of the fundamental properties of electricity.

The computer's central processing unit or CPU is where the work of the system occurs. The CPU is made up of three principal parts.

The first is the **arithmetical and logical unit** that performs functions like addition, subtraction, multiplication, division, and logical functions such as comparing numbers with one another to determine lesser than, greater than, or equal to.

The second major CPU element is the **memory.** This is often referred to as volatile or erasable memory. Its principal characteristic is that data are stored there temporarily while being manipulated. Like the chalk board we remember from school days, data are placed in memory, arithmetical or logical functions are performed, and the data are removed or erased. Data are held in memory in the presence of electricity. This means that a power interruption (someone turns the computer off or the electricity in the building fails) will cause everything in memory to be erased.

Memory in the computer is usually discussed in terms of **K** or thousands of bytes (1K, however, actually equals, 1,024 bytes, but, when the industry speaks of K, it usually rounds downward to the nearest thousand units). Finally, memory exists in multiples of 2, 4, 8, 16, 32K, and so on. Typically, the larger the number of K in a computer's memory, the more work it can do.

Usable memory in a computer is known as **RAM** for **random access memory.** RAM means that the computer's CPU can place data at any location in memory and, by knowing the location or address, can also retrieve the data. ~~Both CPU and disk storage memory are based on RAM.~~

Another term to know is **ROM.** This stands for **read only memory.** ROM is memory in the CPU that cannot be used to store information. Typically, ROM holds machine instructions that must be present in memory for the computer to function. ROM memory is not accessible to the user except to read data that are already there. It cannot be used to store and process additional data.

In most of the major systems now on the market, the ROM required for machine instructions is provided over and above the advertised system memory. However, not all systems are configured in this way, so the potential buyer should determine how much, if any, of the advertised memory is in ROM. Because ROM is not usable memory, the amount of ROM should be deducted from the advertised amount of memory to determine how much user available memory or RAM remains.

Similarly, the buyer should learn how much memory is required for the operating system, to operate peripheral devices, to run application programs, and to hold data in a given application for processing. In this way, an organization can determine the amount of CPU memory required for its microcomputer. For example, in a 64K laptop computer currently on the market, 40K is required for the word processing application software, leaving 24K for storage and processing of text.

The third part of the CPU is the **control unit.** The control unit, or controller, tells the computer what to do and how to do it--for example, to get data, to perform certain functions on the data, to return data to mass storage, or to place data on the CRT. The controller is the traffic director of the system.

At least three different types of computers are found in today's marketplace: micros, minicomputers, and mainframes. Although each type was distinctly different at its inception, continuing technological development has made differentiation among them increasingly difficult. Nevertheless, differences among types of machines are important to organizations planning to acquire new systems or to upgrade existing ones.

Micros began as single user, single function computers. Current 8-bit micros remain so, but the commercial marketplace now offers 16- and 32-bit micros that increasingly resemble larger systems like minicomputers and mainframes. Indeed, some of these larger micros are multi-programming, multi-user systems, and almost all of them have ample capacity to meet at least some of the requirements of governmental organizations.

The difference between 8-bit, 16-bit, and 32-bit and larger computers is that the computer CPU acts on data in groups of bits. An 8-bit system addresses eight bits or one characater at a time, a 16-bit system twice that, a 32-bit system twice that, and so on. This internal dimension or **bit architecture** of a CPU, among other things, gives it speed in accessing and processing data, provides or limits multiprogramming capability, and determines maximum CPU memory. The larger the bit ~~size~~ Architecture, the faster the system, the greater its processing ability, and the larger the maximum CPU memory. Many application programs of interest to local governments require 128K or more of memory, and they will operate more efficiently on a system with a 256K or larger CPU. For these programs, a 16-bit or larger microcomputer is a better choice than an 8-bit system.

Without additional elements of hardware, known as boards, today's 8-bit micros are limited to 128K, while 16-bit systems will configure to 740K of CPU memory. The IBM PC AT class of machines, based on a somewhat larger microprocessor, has a maximum memory configuration of 3MB.

Larger CPU memory in general means that the computer is faster, can execute larger programs, and can handle more data at one time. Nevertheless, additional memory may not always be usable. For example, the most common single-user operating system for IBM PC, PC AT, and compatible machines cannot take advantage of memory greater than 640K.

One of the most exciting hardware developments to date is that microprocessor manufacturers are poised to release full 32-bit processors for microcomputers. Some of the trade magazines have suggested that 32-bit micros will be on the market by the end of 1986, with volume shipments beginning in 1987. When 32-bit machines become available, the 640K memory limitation will be a thing of the past. Microcomputers will become true multi-user, multi-tasking machines. According to some observers, micros with 32-bit processors will sound the death-knell for minicomputers because they will be just as powerful, will have equal or greater memory capacity, will be user friendly, and will cost less. Of course, multi-user operating systems and application programming will have to catch up with hardware, but this is nothing new. Software rarely has kept pace with hardware developments.

As anyone who has observed the computer hardware industry knows, machines keep getting smaller, less expensive, and more powerful. In the oft-quoted words of a 1982 article in Scientific American,

> If the aircraft industry had evolved as spectacularly as the computer industry over the past 25 years, a Boeing 767 would cost $500 today, and it would circle the globe in 20 minutes on a gallon of fuel.[12]

Until recently, minicomputers were typically 16-bit systems. Today, however, most minicomputer manufacturers sell nothing but systems based on 32-bit architecture. Minicomputers, while physically more imposing than micros, are relatively small computers, sometimes no larger than a two-drawer filing cabinet. Mini's have CPU memory capacities in the 12- to ~~14~~ 20-megabyte range when fully configured and can support 60-~~80~~ 120 terminals and printers. Mainframes are even larger computers, able to support even more users at greater speed. They are also more expensive than minicomputers which, in turn, are considerably more expensive than microcomputers. The larger the system, other things being equal, the more processing capacity, the greater the speed of processing, and the more expensive it is.

Although this book focuses on microcomputers, the reader should bear in mind that computer size and type are important to an organization's computing and information management requirements. For some, 8-bit systems will be sufficient. Others will require 16-bit micros, others will need multi-user micros, and still others will require minicomputers or mainframes. The type and size of computer for an organization are determined by the number of applications, number of users, types and amounts of data to be processed and stored, frequencies of transactions and processing, and requirements of the software.

**Peripheral Devices**

The CPU cannot work alone. Three vital functions are missing--input, output, and mass storage. Various devices are used to perform these functions. Perhaps the most common input device on a microcomputer is the **terminal**, often called a CRT (cathode ray tube), VDT (video display tube), video display monitor, or just plain monitor. This device looks like a small television screen. Commands and data that are entered into the system appear on the screen for the user to review. Additional input devices include optical character readers, magnetic tape units, magnetic disk units, card readers, and voice recognition units.

**Monitors** for microcomputer video monitors typically have 12-inch screens that can display 80 columns and 24 lines of information. Monitors are available in black and white, green, and amber. Full color monitors are also available. Decisions on screen color and whether to use a color monitor should be based on considerations such as eye comfort and functions to be performed. For example, if color graphics will not be used, a color monitor may not be required. Potential users should test various screen sizes and colors before purchasing.

Microcomputers are sold with several different types of **keyboards.** A local government planning to buy a micro should specify a typewriter-style keyboard. The keyboard should also have special function keys that allow the user to give commands to the system with a single keystroke. A ten-key numeric pad should be included in the keyboard for entering numerical data. Potential users should test different styles of keyboards to ensure that the one selected can be used easily and efficiently. The users' comfort with the keyboard is very important because the keyboard is where they will do most of their work on the system.

Another input device is available as a partial alternative to the keyboard. This device is known as the **mouse,** a small box attached by a wire to the computer. By moving the mouse on the desktop, the user moves a cursor on the video monitor screen. A button on the mouse enables the user to give commands to the system by selecting appropriate choices of actions that appear on the screen. Even with the mouse, data and text must be entered into the system using the keyboard.

**Mass storage** on a microcomputer system can be likened to the vertical filing cabinets found in most offices. A mass storage unit is where the database (all records and files) of the organization is kept. Memory in the CPU, on the other hand, is like the single file drawer in an executive's desk, where only the files being used for current projects are kept.

In microcomputer systems, **magnetic disk** is the most common storage medium. **Magnetic tape** is also used frequently. The major difference between these storage media is that with disk, data are stored under what is known as the random access method, ~~or RAM~~. Data stored on tape are stored sequentially. Hence, access time for disk is much faster. Quick retrieval and steadily decreasing prices have made disk storage the preferred method for data that must be available ~~for~~ instant ~~retrieval~~.

Nevertheless, magnetic tape units are recommended strongly for systems with 20MB or larger hard disk drives unless some other alternative is available and used. Archives and infrequently used files can be stored on tape efficiently. Tape drives are also useful for backup on larger systems.

Two common types of disk storage devices are the **floppy disk** and the **hard disk.** Floppy disks (or diskettes) look like 45 rpm records and are somewhat flexible, hence the name. Floppies come in various sizes, but 3 1/2-inch, 5 1/4-inch, and 8-inch sizes are the most common. They can be inserted and removed from their **disk drives** as needed. Floppy disks typically hold from about 150K to over one million bytes of data. If hardware development continues at its present rate, floppies with greater storage ability can be expected on the market in the near future.

Hard disks differ from floppies in three principal ways. First, they are rigid, not flexible. Second, they hold far more data, 5, 10, and 20MB being common sizes, with hard disk drives of up to 80MB now on the market. (**MB** stands for **megabyte** and means millions of bytes.) Third, hard disks are contained in sealed units or disk drives from which they cannot be removed.

Data are magnetically encoded onto disk or tape for storage. Unlike the volatile memory of the CPU in which data are held electronically, data placed magnetically on disk or tape will remain there until erased by the computer user. Loss of power or fluctuations in power will not cause loss of data on disk. However, exposure to magnets, including the otherwise harmless paperclip container with a magnet at its mouth, can play havoc with data and programming on disks.

In addition, accidents do happen. Tapes can break, coffee can be spilled on a disk, and mechanical failures can occur. These and other problems can destroy all data on a disk in an instant. Making copies of all data stored on disks and tapes is essential. These copies are called **backups.**

For both floppy and hard disk systems, backup is an important consideration. Floppy disks can serve as backups to other floppies. Similarly, floppies can be used to back up hard disks, but a large number of floppies and a fair amount of time may be necessary (30 360K floppies are needed to back up a 10MB hard disk drive). Hence, magnetic tape is often used for backup on micros that have large disk storage systems.

Some microcomputers are sold with built-in hard disk drives. This is true, for example, of the IBM PC XT, PC AT, and compatible machines. Owners of most machines with only floppy disks can buy external hard disk drives and connect them to their micros. Within the past few years, an alternative to the external disk drive has been developed. ~~This is known as the hardcard.~~ It is a ~~fixed~~ hard disk drive that is the size of an expansion card and fits into a standard expansion slot inside an IBM or compatible microcomputer.

The Iomega Corporation has developed an alternative mass storage mechanism called the Bernouilli Box, and both Kodak and Tandy have released similar devices. The Bernouilli Box combines the virtues of hard and floppy disks with two important differences. It is a disk drive with slots for two removable 10MB or 20MB disk cartridges. With cartridges in both slots, backup of large amounts of data is easy and quick.

Equally important, the Bernouilli Box operates on a different principle than standard Winchester type disk drives. In a Winchester drive, the disk rotates at a high speed, and a device known as a read-write head (think of a phonograph tone arm and stylus) rapidly moves back and forth only thousanths of an inch above the disk surface. Should someone bump the disk drive, the head be out of alignment, or a speck of dust collect on the disk, the head can crash on the disk and destroy the disk and the data on it.

Head crashes cannot occur on a Bernouilli Box because the Bernoulli engineering principle is different from that of Winchester technology. In the Bernouilli Box, the disk is flexible, and, as it rotates, an air bubble is created that raises the disk up to a fixed head. The worst that can happen is for the disk to fall away from the head and interrupt information exchange between the disk and CPU. No data are lost and the system can be restarted easily.

**Printers** are the most common output devices for hard copy materials on microcomputers. Local goverments need to be concerned with three basic types of printers--the **dot matrix**, the **letter quality, and the laser printer.** A fourth type, the thermal printer, is also available but its limitations, especially its lack of speed and poor print quality when compared with other machines, make it unsuitable for office use.

Dot matrix printers form characters by printing a series of dots within a specified matrix as shown in Figure III-1. These printers are suitable for printing bills, checks, budget reports, and other documents that do not need to be of typewritten or typeset quality. Many dot matrix printers on the market, however, can also offer print that closely resembles that of a typewriter. Dot matrix printers cost from a few hundred to a few thousand dollars, depending upon speed, durability, and capacity.

Letter quality printers get their name from printing that looks as if it came from a typewriter. They are especially good for correspondence, narrative reports, manuscripts, and the like. Although letter quality printers costing a few hundred dollars are now on the market, to get the speed, durability, and capacity needed for most local government work, a price of $2,000-$4,000 is more typical.

Dot matrix and letter quality printers are also known as impact printers. This is because keys or devices known as pins impact on inked ribbon and leave the resulting image on paper.

The third type of printer is the laser. It gets its name because a laser is used to create the image that is printed by this device. Laser printers operate somewhat like photocopiers because an image is created on a rotating drum and an entire page is printed when the drum contacts the paper. Laser printers are much faster than impact printers and produce **superior** images. They are also more expensive, beginning at about ~~$4,000.~~ $3,000.

All micros of any consequence to local governments are equipped with things called **ports** or **interfaces.** A port is a physical connection to the computer that allows peripheral devices to be connected to the CPU and data to be transmitted between them and the CPU.

A **serial port** on a computer allows data to be transmitted one bit at a time or in series. A **parallel port** allows data to be sent in groups of bits, typically a byte at a time, or in parallel. The difference between serial and parallel data communication is important primarily in relation to printers. Most micros on the market come with parallel interface to their printers. However, this is one industry where very few things are standard, and some systems are equipped with serial ports for their printers. For example, IBM and IBM-compatible micros are equipped with both parallel and serial ports. Apple IIe and IIc machines have only serial ports. And, the Epson Company, which manufactures computers and mainly, ~~if not exclusively,~~ parallel printers, sells a laptop computer with only a serial port. A special interface or adapter is required to use a parallel printer with the Epson laptop computer and Apple micros. This is because a printer built for parallel communication will not work with a micro that has only serial ports (and vice versa) unless a special hardware attachment to convert parallel transmission to serial is added.

Another important peripheral device for a microcomputer system is the **modem.** Modem stands for **mo**dulator/**dem**odulator. It is a device that enables computers to communicate with one another. Essentially, a modem takes the electronic signals of the computer and changes them into analog signals that can be transmitted on ordinary telephone lines. A modem at the other end receives the analog signals and translates these into bits that can be read by the computer. To put it another way, the modem changes the computer's digital or off-on signal to an analog or wave signal, sends the analog signal across a telephone line, and a modem at the other end translates the analog wave into a digital signal for the receiving computer.

An organization needs a modem for its microcomputer to be able to communicate with other micros, mainframes, or minicomputers, or to be able to interact with numerous computerized networks and databases around the country. Modems typically operate at transmission speeds of 300, 1,200, 2,400, 4,800, and 9,600 bps (bits per second). The higher the speed, the faster the information exchange. However, unless caution is exercised and modems with error checking capability are acquired, data transmission at higher speed (over 1,200 bps) on voice grade telephone lines can result in transmission errors.

Many machines on the market are sold with unused **expansion slots.** These are physical spaces inside the console where additional hardware devices can be attached. Such devices may include memory expansion boards, accelerator boards, math coprocessors (which speed up mathematic calculation), communication boards, graphics boards, and multifunction boards that may combine additional memory with other capabilities, such as printer ports and a system clock. The wise purchaser will buy a micro that has enough expansion slots to meet future system expansion requirements.

One feature of potential importance to microcomputer users is **graphics.** For some machines, an expansion graphics board is required, while on others, graphics capability is a standard feature. Graphics enable the user to create pie and bar charts, maps, and drawings. Graphics can enhance the presentation of narrative reports and is almost essential for planning and engineering applications.

Of course, along with a graphics board or built-in capability, a graphics system must have **graphics software** and a printer or **plotter** for graphic representations and drawings. Many dot matrix printers can produce limited graphics, and laser printers have an even greater graphics capability. For maps and engineering design work, plotters are almost essential. A plotter uses one or more ink pens that actually draw the required images. Color printers and plotters are available, and naturally, the greater the sophistication of the graphics output device, the more expensive it is.

**Configuring a System.**

The amount of CPU memory and disk storage and the number and type of peripheral devices that a local government needs (known as system configuration) are directly related to the number and type of functions that will be performed on the system, the number of users, the size of the database, and the volumes and frequencies of activity in each function that will be automated. Generally speaking, no two systems will be identical because the organizations in which they operate will be different. However, for most local governments, the following is a minimum hardware configuration. The microcomputer should have at least 256K of CPU memory, a dual floppy disk drive, a monitor, and a dot matrix printer. On today's market, such a system can be expected to cost from $1,500 to $2,000, exclusive of software. A similarly configured hard disk system will cost from $2,000 to $2,500. For many organizations, especially those that plan to use a micro extensively, this minimum configuration may not be adequate. Additional memory, a hard disk drive, a faster, sturdier printer, a modem, and possibly a graphics capability will be required.

A guide showing the typical conversion of typed material to bits and bytes in computer memory is reproduced below. This guide may be helpful in determining the amount of memory and storage for a given activity.

Figure III-1

BITS, BYTES, AND STORAGE

One byte (eight bits) of disk space or main memory is necessary to store one letter or symbol.

A typewritten page holds approximately 250 words (1,500 characters and spaces). Thus, 1,500 bytes (12,000 bits) of computer space are necessary to store a page of text. Therefore:

- o 1.5K of computer space is needed to hold one typewritten page (in main memory or on a disk),
- o 30K of computer space is needed to hold 20 typewritten pages, and
- o 150K of computer space is needed to hold 100 typewritten pages.

Source: Adapted with permission from Guide to Personal Computing, Digital Equipment Corporation, 1983, p. 44.

# CHAPTER IV -- MICROCOMPUTER SOFTWARE

Software is the most important part of a microcomputer system. Most commercially available microcomputer hardware will work reliably and effectively. What enables a microcomputer system to perform work, and what causes persons implementing microcomputers in local governments to become either heroes or villians, is something called **software.**

Software is called that because it is not hardware, but it really is not soft either. In fact, it cannot be sensed at all in a tactile manner. It is called software because of the earlier evolution of the term hardware for machinery. If machinery is hard, then programming must be soft.

Software, otherwise known as **programming**, is more difficult for many persons to comprehend than hardware. Yet, without software, the computer is an expensive, dumb hunk of metal, plastic, wires, and silicon. It does nothing but take up space.

Microcomputers can perform only one action at a time. Their incredible speed enables them to perform tasks quickly and efficiently. To do so, micros must be given precise instructions for each step of an activity. These sets of instructions are called programs or software.

Several kinds of programs exist, but, for governmental purposes the two most important categories of software are **operating systems** and **application programs.**

## Operating Systems

An **operating system** resides on the computer's memory and controls the activities of the rest of the system, including the application software and the functions of the peripheral devices. For example, the operating system communicates with the video monitor to receive and execute commands. It assigns print jobs to printers and establishes printing priorities. It also keeps track of the data stored on disks and enables the user to write data to or read data from the disk and to perform various actions on these data, including adding, deleting, and modifying data. Operating systems are either provided by computer manufacturers or they are written especially for certain classes of machines.

Several operating systems are available for microcomputers. As is true for many other aspects of computer technology, most operating systems are incompatible with one another and will run only on specific brands and types of micros. Among other things, this means that **application programs written to run on one operating system probably will not run on another.**

Somewhat of a standard operating system has emerged for 8-bit micros. It is called **CP/M** for **c**ontrol **p**rogram for **m**icrocomputers. A few of the micros that use CP/M as their principal operating system are the Kaypro II, NEC 8800, and Epson QX-10.

However, several other operating systems for 8-bit systems also exist. These include **TRSDOS** (DOS stands for **d**isk **o**perating **s**ystem) for Radio Shack's 8-bit micros, **Apple DOS** and **Pro DOS** for Apple micros, and others. Increasingly, these and many other 8-bit micros can be modified to use CP/M by adding a special hardware card or board to the CPU.

Three major competing operating system have been developed for 16-bit micros. **PC-DOS** and its sister **MS-DOS** (both developed by the Microsoft Corporation) are operating systems for the IBM PC and its compatibles. Currently, MS-DOS appears to have established a de facto standard for 16-bit micros. However, a 16-bit version of CP/M known as **CP/M-86** is available, and some 16-bit machines use their own proprietary operating systems.

Many experts feel that AT&T's **UNIX** operating system and its **XENIX** counterpart (developed by Microsoft) will become leading operating systems for larger micros, such as the IBM PC AT and compatibles, the AT&T UNIX PC, and Tandy's TRS Model 16 and its successors. UNIX and XENIX are multi-user operating systems that support the simultaneous activity of a group of users. At this writing, however, most micros--even those like the PC AT that can support multiple users--are used in governmental organizations primarily as stand-alone, single-user machines.

Two things determine whether a microcomputer is a single or multi-user machine--the microprocessor and the operating system. Micros based on 8-bit processors, such as the Zilog Z-80, and 16/8-bit processors, such as the Intel 8088, are limited strictly to single-user, single function use. Larger, faster processors, such as the Intel 80286 and Motorola 68000, can be used in multi-user machines, but they must have multi-user operating systems. The IBM PC AT, for example, is based on the Intel 80286 chip. When it runs under the XENIX operating system, it is a multi-user machine. However, when the PC DOS operating system is used, the PC AT is a single-user machine, because currently PC DOS is a single-user operating system.

**Application Software**

**General Considerations.** For most local governments, **application programing**, is the single most important part of the microcomputer system. Application programming performs the work of the organization, including functions such as word processsing, database managment, accounting, budgeting, billing, inventory control, payroll, personnel management, equipment management, police recordkeeping and reporting.

Each program, whether an application program or an operating system, is really made up of many modules or subprogram elements. A payroll program, for example, should not only order payroll checks printed, it should verify the amount of each check, make and record all deductions, update the general ledger and all subsidiary ledgers, and prepare payroll reports and reports of all deductions. Each function requires a separate program element.

The more complicated the task, the more complex the program required. After all, a program is a step-by-step reconstruction of all procedures that must be performed manually to complete a task.

Local governments have six options when acquiring microcomputer software: (1) off-the-shelf software, (2) public-domain software, (3) packaged software designed for local government functions, (4) software developed by another organization which may have to be modified to meet local requirements, (5) custom software written by an outside organization, or (6) software created by in-house staff.

Most local governments using micros rely on off-the-shelf programming. Wordstar, dBase III, and Lotus 1-2-3, are popular examples of software created for the horizontal market and applicable to a variety of organizations and settings. Off-the-shelf software is relatively easy to use (some programs more so than others), inexpensive, and available at most microcomputer sales outlets.

Public-domain software is programming that is available with no copywrite protection. It is often written by computer hobbyists, members of computer clubs, or by persons in specific vertical markets (for example, public works and engineering) to share with other potential users. Public-domain software is often free or available for a nominal fee and can be acquired from microcomputer users' groups, electronic bulletin boards, and distributors of public-domain software.

Packaged software is programming written by software houses, value added dealers, or other organizations (for example, engineering or accounting firms) for a vertical market. Vertical market is just another way of describing a particular industry or sector of the economy, such as dentists' offices, retail stores, or local governments. According to International Data Corporation, the microcomputer vertical market by industry was divided as follows in 1985:

Figure IV-1
MICROCOMPUTER VERTICLE MARKET DISTRIBUTION

| Market Sector | Percent |
|---|---|
| Manufacturing | 18.6 |
| Government | 13.6 |
| Medical/Dental | 13.4 |
| Banking/Finance | 12.9 |
| Wholesale/Distribution | 11.6 |
| All Other (including science, engineering, and rental) | 29.9 |
| Total | 100.0 |

Source: *PC Week*, September 17, 1985. Data provided by International Data Corporation.

In the past four years, the number of organizations offering packaged local government software has grown tremendously and the quality of the software has improved as well. In late 1985, I identified almost 60 organizations that offer packaged microcomputer software for general local govenment functions. These organizations probably represent only a small percentage of those available.[13] Currently, the International City Management Association (ICMA) is producing a comprehensive listing of microcomputer software available to local governments, and, in 1987, ICMA will start publishing periodic reviews of this software.

Both packaged and public-domain software may require **modifications** to meet purchasers' requirements. Modifications can be relatively simple things, like changing headings and inserting the name of your city or county on reports. They can also be quite complex, like changing the way in which payroll checks and utility bills are printed and changing the mathematical formulas used to calculate checks and bills. The more complex changes can be difficult, time-consuming, and expensive. Most packaged software vendors will make at least some modifications to their products, providing they are told clearly and concisely what modifications are required. The cost for making modifications may be a part of the price of the package or it may be an additional fee. Modifications to public-domain software must be made by the purchaser, either by using internal resources, by hiring an outside programmer, or by contracting with the author of the software. Modifications are not offered by vendors of off-the-shelf software and generally are not needed.

Acquiring software from another organization, whether a business or local government, can be an effective means of getting good quality programming at low cost. This is especially true of small specialized programs, and programs written for use with off-the-shelf software, such as Lotus 1-2-3 or dBase, for financial analysis and recordkeeping activities. However, there are negative aspects of this method. They include lack of documentation, lack of training, and lack of support from the software supplier if the program does not work as advertised. A final weakness of this approach is that programs must be modified by the purchaser, either using in-house staff or by hiring outside programmers. For example, a city purchased a softball scheduling program from another community several hundred miles away on the strength of the program's advertised capabilities. The purchasers found that the program did not meet their needs and they did not have the ability to modify it. Consequently, this program has not been used at all. A more cautious approach to buying software from another organization, including careful testing before buying, can produce satisfactory results.

Custom-written software, whether written by outside programmers or in-house staff, can also be a satisfactory method of acquiring programming. The public works department for the city of Omaha, Nebraska, hired a student from a local university for a summer to write a package for producing engineers' estimates of construction project activities, quantities, and costs. This program is also used to bid projects, to evaluate bid responses, to track projects underway, and to authorize payments to contractors. Omaha's experience with this program has been highly favorable. Considerable time is saved, accuracy is high, and an otherwise tedious manual process is now automated. The Olathe, Kansas, public works department has enjoyed highly cost-effective results from hiring an outside programmer to develop several applications. Two of the reasons for Olathe's success are that public works officials have communicated their needs clearly to the programmer and he in turn has been very responsive to those needs.

Custom-written software can have drawbacks. Programmers do not always like to write documentation and absence of documentation can be a serious deficiency if the local government wants to modify the program and finds that the software house has gone broke or the programmer cannot be contacted.

Custom-written software can also be excessively expensive. Indeed, in order of most to least expensive, custom programming usually heads the list, followed by packaged and off-the-shelf software. The cost of programs written in-house and programs acquired from other organizations vary depending on several factors, including the complexity of the application and the extent of modifications required.

Off-the-shelf and packaged programming have distinct advantages. In addition to being the least expensive method of acquiring software, off-the-shelf software is applicable to a range of governmental functions. More vendors are beginning to supply either full turnkey microcomputer systems (hardware, software, and support services) or packaged software developed specifically for local governmental organizations.

While hardware is increasingly inexpensive, software is increasingly expensive. This is because technological advances have resulted in significant hardware price reductions relative to value. The creation and support of computer software, on the other hand, involves the work of people, instead of technology, and people's time is expensive. This is another reason why a government's software decision is more important than its hardware decision.

Programming is a highly specialized discipline requiring persons with equally specialized skills. These skills often are not related to the functional requirements of local government. That is, relatively few programmers know much about government and governmental requirements. Recent data show that programmers are in relatively short supply nationally and command relatively high salaries. The 1985 salary, for example, for entry-level programmers averaged over $20,000.[14] Experienced programmers earn even more. Hence, both custom programming by outside organizations and in-house programming can be costly, especially for small governments.

**Off-the-Shelf Software.** Application programming to perform functions in local governments is widely available. The first class of programming I will discuss is off-the-shelf software and includes spreadsheets, word processors, and database management software.

**Spreadsheet programs** are considered to be the software that sold microcomputers to businesses and local governments. As Figure IV-2 shows, spreadsheets remain the most frequently used programs for microcomputers.

Figure IV-2
PC SOFTWARE MARKET BY APPLICATION

| Application | Percent |
|---|---|
| Spreadsheet | 34 |
| Word processing | 30 |
| Database management | 22 |
| Integrated | 5 |
| Accounting | 3 |
| Graphics | 3 |
| Other | 3 |
| | 100 |

Source: PC Week, February 28, 1986. Data provided by Info Corp.

A spreadsheet on a microcomputer is the electronic equivalent of the paper ledger sheet with which most of us are familiar. It consists of horizontal **rows** and vertical **columns**. Intersections of rows and columns are called **cells**. Typically a spreadsheet is used for budget preparation. The lefthand column is used for budgetary line items, the next three columns contain last year's actual expenditures, this year's budget, and expenditures for this year to date, and the last column contains blank spaces for next year's budget. The rows contain information specific to a line item for each budget year (see Figure IV-3).

The power, and hence utility, of an electronic spreadsheet comes from its ability to recalculate instantly. In addition to words (line item descriptions) and numbers (budget figures), the spreadsheet also contains formulas. For example, when calculating fringe benefits or administrative overhead costs, percentages may be applied to direct labor costs (for example,

FIGURE IV - 3

BUDGET SPREADSHEET (EXPENDITURE)
CITY OF EVERYTOWN

FUND 203 LOCAL STREETS

440.000 STREET MAINTENANCE

| ITEM | PRIOR YEAR (1984-85) ACTUAL | CURRENT YEAR (1985-86) BUDGET | CURRENT YEAR (8-MONTHS) YEAR TO DATE | NEXT YEAR (1986-87) DEPARTMENT REQUEST | NEXT YEAR (1986-87) MANAGER REQUEST |
|---|---|---|---|---|---|
| 706.000 SALARIES PERMANENT EMPLOYEES | 32,707 | 34,000 | 32,817 | 34,650 | 34,650 |
| 713.000 FRINGE BENEFITS/OVERHEAD | 17,716 | 18,080 | 17,450 | 18,740 | 18,740 |
| 782.000 STREET MAINTENANCE SUPPLIES | 3,948 | 5,000 | 2,869 | 5,000 | 5,000 |
| 784.000 SNOW CONTROL SUPPLIES | 5,506 | 6,210 | 5,612 | 7,830 | 7,830 |
| 786.000 TRAFFIC CONTROL SUPPLIES | 455 | 950 | 394 | 1,000 | 1,000 |
| 802.000 ADMINISTRATION/MGMT FEES | 8,619 | 8,050 | 8,558 | 8,925 | 8,925 |
| 808.000 INDEPENDENT AUDIT | 845 | 900 | 900 | 925 | 925 |
| 832.000 TREE TRIM/SPRAY/REMOVAL | 46,483 | 38,640 | 49,263 | 39,855 | 39,855 |
| 925.000 TRAFFIC SIGNAL MAINTENANCE | 936 | 1,265 | 1,073 | 1,265 | 1,265 |
| 926.000 STREET LIGHTING | 527 | 605 | 564 | 655 | 655 |
| 943.000 EQUIPMENT RENTAL | 41,756 | 38,960 | 36,755 | 40,520 | 40,520 |
| 980.100 STREET RESURFACING & REPAIR | 0 | 0 | 0 | 0 | 0 |
| STREET MAINTENANCE | 159,498 | 152,660 | 156,225 | 159,365 | 159,365 |
| LOCAL STREET FUNDS | 159,498 | 152,660 | 156,225 | 159,365 | 159,365 |

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fringe benefits equal 125 percent of direct labor costs, administrative overhead equals 160 percent of direct labor and fringe benefit costs). These and other formulas are written into the spreadsheet by the user. Dollar amounts and formulas can be changed at the user's command and the electronic spreadsheet will recalculate instantly and spread the results to all affected cells and to the bottom line.

The ability to recalculate and the speed with which recalculations are made, enable users to examine several budgetary alternatives and to do so quickly and accurately. Many other types of financial analyses are possible using spreadsheets (for example, investment management, debt management, and cost analyses) and in each case users can play "what if" games. What if fringe benefit costs increase by 5 percent? What if salaries increase by 7 percent? What if revenues decline by 2 percent?

Most local governments that use spreadsheets praise them. In addition to saving time and promoting accuracy, they enable users to conduct more in-depth analyses, to examine more data, and to evaluate more alternatives, thus producing better information for management decisionmaking. Examples from cities studied show that the time required for budget preparation and other financial analyses was reduced dramatically. Also, cost-avoidance and real dollar savings occurred because of the use of spreadsheets.

The following are some factors to consider when buying spreadsheet programs:

- Ease of use--How much time is required to learn to use the spreadsheet, how much re-learning is required after a user has been away from the program?

- Memory requirement--What is the minimum CPU memory to run the program? What is the amount typically recommended for acceptable responsiveness?

- Storage requirement--Is a hard disk required? How many bytes of storage are needed for a typical spreadsheet?

- o Maximum number of rows and columns--What size spreadsheet can be created? Maximum sizes vary from a low of 50 rows x 50 columns to a high of 32,000 rows x 32,000 columns. How large a spreadsheet will you need?

- o Compatibility with other packages--Can data from the spreadsheet be transferred and used with data from other spreadsheets, word processors, or database programs? Will the program create ASCII files? (These are files that can be understood by other computers.)

- o Degree of integration--Is it a stand-alone spreadsheet or does it feature some degree of integration with other packages, such as word processing, database management, or graphics? Can it be integrated with your financial management system or at least access data from that system?

Generally, **word processing** is the second most widely used off-the-shelf package on micros and ~~possibly~~ it ~~is~~ may be the most widely used package on micros in local governments. A word processing program enables a user to create a document by entering text into the micro in a manner similar to using a typewriter. But, the similarity ends at the keyboard text entry. Electronic word processing enables the user to edit text on the video monitor screen by deleting, inserting, correcting, and moving material electronically. Word processing eliminates strikeovers and white-outs.

Material can be formatted in various ways, including indentations, headings and subheadings, margins, and right and left justifications. Once entered, text can be stored for later use or it can be retrieved, modified, or reused. Material can be printed in various formats as well, double space (for editing), single space (for final copy), and with automatic page numbering, headings, and titles. Finally, text from many documents can be merged into a single printed letter or report, all without having to retype or cut and paste.

Many features are available on the better word processing packages, such as the following:

- o Cursor movement (up, down, left, right, by word, by sentence, and to specific locations in the text),
- o Scrolling through the document,
- o Copying blocks of material,
- o Searching for keywords or phrases,
- o Global searching and replacing,
- o Underlining and bold face and italic printing (some of which will also depend on printer capabilities),
- o Hyphenation,
- o Standard and user defined dictionaries,
- o Spelling checker,
- o Footnotes and end notes,
- o Automatic indexing,
- o Compatibility with other packages, (for example, spreadsheets and databases) and the ability to create ASCII files,
- o Outlining, and
- o Sub- and superscript.

As with other packages, ease of learning and ease of use are important features. However, the simpler word processors (or spreadsheets or database managers) are often more limited in their capabilities. Users should examine their word processing requirements before they buy a package to ensure that the package will meet their needs. Figure IV-4 lists 1985's top selling word processing packages for microcomputers.

Figure IV-4

WORD PROCESSING PACKAGES
BY PERCENTAGE OF SALES, 1985

| Package | Percent |
|---|---|
| pfs:Write | 16 |
| MacWrite | 12 |
| Bank Street Writer | 10 |
| Multimate | 9 |
| Wordstar | 9 |
| WordPerfect | 6 |
| Microsoft Word | 6 |
| DisplayWrite | 5 |
| VolksWriter | 4 |
| Tandy Script | 2 |
| All others | 21 |

Source: PC Week, March 11, 1986.
Data provided by InfoCorp.

**Database management** programs enable users to create and manage their own unique files and records on an electronic medium rather than on paper records that are placed in manila folders and stored in metal filing cabinets. As in the paper system, a **file** is a collection of similar records. A **record** is a single document containing specific information. A **system** includes all of the files associated with the performance of a given function. For example, a payroll/personnel system contains all of the files necessary to maintain accurate information on an organization's employees; to pay the employees; to maintain an accounting of payroll receipts; to make payments to FICA, retirement funds, insurers, and others.

An important factor in the usability of a database is the user's **design**, that is the way in which the data on the records are organized and displayed. Care must be taken, for example, to ensure the **fields** (which are groupings of spaces into which alpha or numeric characters are inserted) are big enough to hold the required data and are located logically on a record.

Take a master employee record as an example. At the minimum, the following information should be kept on each employee and each information item represents a field on the master record:

Name (last, first, middle),

Address (apartment, street, city, state, zip code),

Telephone number (home),

Emergency information,

Social security number,

Race,

Sex,

Job classification/title,

Employee number,

Date hired,

Pay rate, and

Pay type.

This is the basic information needed for all employees. It will be augmented by information contained in other files. These files might include records on tax information and status, leave accumulated and taken, department and cost center assignment, promotion and longevity information, disciplinary actions, and benefit programs. All of the information in these files constitutes the organization's payroll/personnel **database.**

After the file is designed and the data are entered, the user can use the database program to manipulate data in routine ways and also to accomplish tasks that would be prohibitive with a manual system. Reports (for example, number of employees, employees by job title and pay classification, an organizational telephone list, and equal employment opportunity reports) can be produced easily and quickly. Unique inquiries can be made into the files and the program should enable the user to undertake multiple sorts through the database (for example, list all employees who have been employed for 5, 10, and 15 years; list employees in alphabetical order by department; and list employees in alphabetical order by department and include the date they were hired).

The more powerful, more sophisticated database programs enable users to create larger, more complex, and more numerous files, to undertake sorts on multiple fields, and to search for data from multiple files. Indeed, the capability to search for data among multiple files is a key difference between true database management programs (such as dBase and R:base) and file management programs (such as pfs:File) which can only deal with one file at a time.

According to an article in Personal Computing,[15] a database management program should allow the user to do the following:

- o Create a database structure,
- o Add new information,
- o Sort the information,
- o Search for information,
- o Report data in the form desired,
- o Correct data and edit text, and
- o Remove data.

I would add the following capabilities to the list:

- o Sort and search among multiple files,
- o Be compatible with other major packages (spreadsheets, word processors, and databases) and be capable of producing ASCII files, and

- Be relatively easy to learn to use. (A trade-off here is that the easier the program is to use, the less powerful the database management program it is likely to be.)

Among other features to look for in a database program, the following are especially important:

- Maximum number of fields per record,
- Maximum field size,
- Maximum number of records,
- Maximum record size,
- Maximum number of fields it can sort in a single sort,
- Multiple report formats,
- Password (or other) file protection,
- A **procedural language** (that is, the ability to write brief programs), a **query language** (that is, the ability to format brief questions for inquiry into the database),
- Command or menu driven,
- Minimum memory requirement and minimum memory recommended, and
- Storage requirement (number of floppies, whether hard disk required).

The best selling database management programs in 1985 were dBase (60 percent of the market), R:base (12 percent), and Dataease (11 percent). All others accounted for about 17 percent of the market.[16]

Another class of off-the-shelf software of interest to local governments is **graphics.** Graphics programs enable users to create pie, bar, and line charts, to create sophisticated mapping and engineering drawings, to display and print results in black and white and in color. To produce graphics, a microcomputer must have an add-on graphics board or a built-in graphics capability and a graphics printer or a plotter. Some graphics programs are bundled with spreadsheet applications (for example, Lotus 1-2-3) while others are essentially stand-alone products.

No discussion of off-the-shelf software would be complete without mention of **office automation software** (OA) including word processing and electronic mail. Some of these programs operate on standard microcomputers, others on specialized machines called word processors, and still others are sold as office automation systems. The impact of office automation promises to be enormous, especially when word processing and electronic mail programming become linked to other computer systems and when stand-alone word processors gain capabilities to perform additional data processing functions. To date, however, governmental organizations have had only limited experience with OA, although some local governments are moving rapidly in that direction. Englewood, Colorado, for example, recently installed an OA system with 16 work stations for use by secretaries throughout city hall, and Pasadena, California, has an in-house computer system and over 100 micros that are capable of accessing a comprehensive OA package that enables users to schedule work and send electronic mail.

**Decision-support** is another term that is used with microcomputers. Some writers contend that decision-support, or more properly decision-support systems, are application programs that enable users to model or simulate real-world conditions. To these persons, complex financial modeling programs are synonymous with decision support.

As far as I am concerned decision-support is the result of advanced microcomputer use, regardless of software employed. This means that a fleet manager who uses a database program to analyze vehicle efficiency, a planner who uses a spreadsheet to predict costs and revenues associated with an annexation, and an engineer who uses a packaged program to examine alternative roadway or sewer designs are using the power of the microcomputer for decision support. They use the micro to collect, store, and analyze information and to examine alternative courses of action. This is decision support.

**Training software** is another class of programming that should be of interest to local governments. Training software is available as on-disk tutorials that come with some off-the-shelf and packaged application programs and also as after market disk-based training. In both cases, the training software supplements users' manuals and vendor and third-party training. Training software provides users with instructions on how to use a program and with risk-free practice. They can create, edit, and manipulate practice documents and files, while learning the commands and menus that are part of the application. The price of training software ranges from a low of $50 to as much as $2,000 for individual programs, although a range of $50 to $150 is more typical. On-disk tutorials that are part of application packages are part of the price of those packages.

Prices for microcomputer software vary widely. Public domain software can be acquired at little or no cost. Some off-the-shelf programs for functions such as word processing, spreadsheets, and database management can be purchased for as little as $50 per package, others cost around $700. More complex, off-the-shelf programming for things such as inventory, payroll, or accounting can cost from $300 to $500 per package. Packaged software for activities such as fund accounting, payroll/personnel, and utility billing may cost from $1,000 to $2,500 per package or more. Custom written programs can be even more expensive. By almost all accounts, however, microcomputer software is considerably less expensive than programming for minicomputers and mainframes.

**Local Government Applications**

Surveys of microcomputer use conducted in 1982, by the International City Management Association, and in 1983, by the Center for Applied Urban Research at the University of Nebraska at Omaha found that micros in local governments were used primarily for word processing or for financial management. These studies also found a sizable demand for microcomputers among local governments, suggesting that an increasing number and variety of applications could be expected to be found on micros in local governments in coming years.[17] As one expert in the field has said about computer use in local government, "The only limits to the use of computer technology are the pocketbook and the imagination."[18] In other words, if a local government wants to use a micro for a particular function and can afford to do so, it will probably be able to find or develop the necessary application.

Recent research indicates that this prediction has come true. That is, micros are being used by local governments in a variety of settings and for a variety of applications. A book published in 1983 by the ICMA, Microcomputers in Local Government (written by city manager James Griesemer) listed many functions of local government that can be performed on microcomputers. These are shown in Figure IV-5. If this figure were replicated today it could be five to ten times as large.

Case studies of micro use in city governments that I conducted in 1985-86, showed that nearly every department of city government is using micros. A 1985 ICMA survey of computing in cities with a population of over 10,000 also showed widespread use of micros in city departments.[19] Certainly some cities had more micros than others, but microcomputer uses were numerous and varied. Most of the software used was off-the-shelf versus packaged, custom-written, or public-domain.

Figure IV-5

LOCAL GOVERNMENTAL MICROCOMPUTER APPLICATIONS

Office and Administration
- Word processing
- File management
- Document locating
- Council minutes index
- Ordinances/resolutions
- Calendar and scheduling
- Financial modeling studies
- Specifications
- Department performance data
- Miscellaneous data/notes
- Statistical comparisons
- Strategic planning
- Management by objectives

Finance
- Accounting
- Budgeting
- Purchasing
- Payroll
- Financial forecasting
- Bond payments and redemptions
- Property assessment
- Tax billing
- Business licenses
- Inventory management
- Utility billing
- Accounts receivable
- Investment management

Personnel
- Recruiting and placement
- Personnel records
- Employee skills inventory
- Training records

Public Safety
- Crime reporting
- Police incident analysis
- Computer-aided dispatch
- Stolen/recovered property
- Officer activity
- Payroll scheduling
- Traffic violation processing
- Accident reports
- Court schedules
- Fire incident analysis

Public Works
- Vehicle maintenance
- Utility billing analysis
- Meter inventory
- Street maintenance planning
- Street condition inventory
- Street lights/traffic signals
- Work orders

Community Development
- Building permits
- Inspection scheduling
- Land-use data
- Capital expenditure projections

Parks and Recreation
- Park facilities inventory
- Parkland maintenance
- Recreation registration/scheduling
- Forestry statistics

Library
- Library circulation
- Library inventory
- On-line card catalog

Source: James R. Griesemer, Microcomputers in Local Government (Washington: International City Management Association, 1983), p. 26.

As mentioned earlier, I recently identified about 60 sources of packaged software for general governmental purposes. I also found over 110 sources for miscellaneous public works management software (fleet, fuel, shop, project, productivity, and inventory), 115 sources for engineering software (calculations; design; mapping and plotting; hydraulics; hydrology; and civil, mechanical, and electrical engineering), and over 50 sources for highway, traffic, and transportation software.[20]

General government, financial management, public works and engineering, and law enforcement represent the largest markets for packaged application software products for local governments. Although fewer in number, packages are available in many other areas as well. Indeed, I cannot imagine a local government function for which packaged software is not available or for which an off-the-shelf word processing, spreadsheet, or database management program would not be applicable, nor can I imagine an area of local government activity in which a micro is not now being used somewhere.

The better software for micros is **integrated.** This is true of off-the-shelf programming where integration means a single product that incorporates word processing, spreadsheet, and database management capabilities and may include graphics and communication. For the off-the-shelf market, integration also means that data formats and commands are identical among modules of a package and that there is no need to convert files or even to switch disks to move among the modules.

For example, I work with an integrated package, Appleworks on an Apple IIc microcomputer. Basic commands are identical for all three modules (word processing, spreadsheet, and database), although additional commands are pertinent to the specific functions of each module. The program also allows the user to create files in all of these modules and to merge them, in whole or in part, with relative ease. Appleworks is also inexpensive, about $150, although it only runs on the Apple IIc.

Integrated products from packaged software vendors in areas such as financial management and police records offer an even greater degree of integration. For example, an integrated fund accounting system should support several major subsystems, including at least the following:

- General ledger,
- Budgetary accounting,
- Accounts receivable,
- Accounts payable,
- Cost accounting, and
- Purchase orders.

These and other modules or subsystems should interface with the general ledger. What is more, when a transaction is made in any module or subsystem, it should automatically update all affected modules or subsystems. For example, a purchase order for $2,500 issued for a new microcomputer system for the city manager should be recorded automatically on the general ledger and as an encumbrance in the budgetary accounting module. When the system arrives, is tested and approved, and payment is made, the check written in the accounts payable module should clear the encumbrance and appear on the budgetary accounting module as an expense of $2,500 from the equipment line item in the city manager's budget. Each transaction should be recorded automatically in a transaction file (or similar module), which can be checked for accuracy and authorization, and then stored for review by external auditors at the end of the fiscal year.

An integrated law enforcement system works pretty much the same way. All entries are recorded on their respective files, related files are updated and a record of transactions is kept for security and internal control. An example might be that when a person is arrested, his or her name is entered on an arrest file. At the same time, the system adds the name and other pertinent information to the master name index and the criminal history file. The system should also search these files and related files (such as outstanding warrants, traffic citations, and parking tickets) to determine if the arrested party has appeared on the system previously or is wanted in connection with a felony or misdemeanor.

The strengths of integrated systems are that they eliminate multiple entry of similar data (thus, reducing the potential for human error) and speed up the recordkeeping process. They also provide managers with access to informatin in various and potentially more useful formats. Mostly, though, they save time. Wherever possible, especially with larger, more complex application packages, governmental organizations should require that packages be fully integrated.

**Software Evaluation**

Once an organization has decided to buy a microcomputer system (more on this in Chapter VI) and has decided on the software it needs, how does it determine whether the software meets its requirements? Evaluation of software, especially packaged and custom-written software, is difficult and nowhere is the following statement more applicable: "What you think you see is not always what you get."

Software suppliers and software buyers often do not speak the same language, and this can complicate the buyer's understanding of the capabilities and limitations of a package. Even where vendors and purchasers understand one another clearly (a rare circumstance), it has been my experience in consulting with many local governments that questions about software are not always fully comprehended or answered by vendors and capabilities are often exaggerated. Sometimes this occurs because sales persons do not know their products well, because of excessive zeal or pressure to make sales, and deliberate deception is not unknown. More often than not, however, misunderstanding occurs because of ignorance by the salesperson and the buyer alike. Salespersons may not know or fully understand a local government's requirements, and they may not fully understand their own software and hardware. Although local government personnel may know how to do their jobs quite well, they may not be able to translate that knowledge into a statement of their computing needs. Furthermore, they are probably not especially literate about computer hardware and software.

How, then, can a prospective buyer evaluate microcomputer software? The first and most important rule is do not believe anything about the capability of a software product unless you have actually seen it and then make sure it will perform those functions correctly and repeatedly and on real data. Second, never accept a promise ("sure it will do that" or "sure, we can make a modification so it will do that" or "no it won't cost much") unless the promise is on paper and has as close to an ironclad guarantee as possible. As a colleague told me several years ago, the second time you hear the phrase "no problem ... no problem," you can be sure you have (or will soon have) a problem.

In general, any software whether off-the-shelf, packaged, or custom-written, should meet three simple but important tests. It should:

- Do what you want,
- How you want it done, and
- When you want it.

The trick is to be able to determine whether the software passes these tests. First, an organization should have a clear idea of what it wants the software to do. A requirements analysis that determines computing and information management needs is essential. (Requirements analyses are discussed in greater detail in Chapter VI.)

Next, it is helpful to read software reviews. For off-the-shelf packages, publications like PC World, PC Week, and Infoworld are valuable. They publish evaluations and buyers guides and also identify the principal characteristics and capabilities that good off-the-shelf programs should meet. In its evaluations of off-the-shelf software, for example, Infoworld rates software as excellent, good, average, poor, and unsatisfactory in the following categories:

- Performance,
- Documentation,
- Ease of learning,
- Ease of use,
- Error handling,
- Support, and
- Value.

Additional categories suggested by two national public accounting firms for off-the-shelf software evaluations include:[21]

- Cost,
- Internal product integration,
- Interface/integration with software from the same vendor,
- Interface with software from other vendors,
- Ease of installation,
- Performance speed, and
- Purchase terms.

The buyer should develop a clear set of specifications against which packaged and custom-written software can be evaluated. An organization must know what it wants to determine if a software package performs as advertised and meets its needs. It is even more important to have written specifications for custom developed software because it will also guide the programmers who are writing it.

Figure IV-6 contains a functional specification for an integrated financial management system for a local government. This specification, which should be modified according to local requirements, has been employed successfully by many small local governments in acquiring mini- and microcomputer based accounting systems.

Figure IV-6

SPECIFICATION FOR
INTEGRATED FINANCIAL MANAGEMENT SYSTEM

The automated financial management system should be fully integrated and designed around a general ledger accounting subsystem. All subsystems should update automatically the general ledger and all other affected subsystems. The financial management system should accommodate encumbrance accounting and accrual and cash management practices. It must include at least the following major subsystems:

A. Standard (probably existing city) chart of accounts.

B. Budgetary accounting--
  * Line item accounting and budgeting,
  * Departmental accounting and budgeting,
  * Fund accounting and budgeting,
  * Program/project accounting and budgeting,
  * Cash and encumbrance accounting, and
  * Accrual accounting.

C. Cash collection/accounts receivable--
  * Cash collection and control, and
  * Cash distribution.

D. Accounts payable--
  * Check preparation, and
  * Check reconciliation.

E. Cost accounting--
  * By fund,
  * By department,
  * By line item, and
  * By program/project.

F. Forecasting/modeling/spreadsheet capability--
  * Revenue, and
  * Expenditures.

G. Vendor files--
  * By vendor,
  * By item/category,
  * By department/division/project, and
  * Three-year history.

H. Auditing requirements--
  * Transaction files,
  * Trial balances, and
  * Audit trail.

I. Purchasing and inventory (desired, not mandatory)--
  * Purchase order and requisition issuance and control, and
  * Inventory control.

J. Capital assets (desired, not mandatory)--
  * Capital asset inventory,
  * Capital asset depreciation, and
  * Capital improvement budgeting.

The second major element of a software evaluation, after development of specifications, is to see the system running in an operating environment (for example, a similar governmental organization) on actual data and to ask questions of users. Vendor conducted demonstrations and descriptive literature written by vendors are no substitute for the real thing. In my experience, however, too few local governments are willing to spend the time (and money) to review software operating in other cities or counties. The purpose of these visits is to examine the way the software works, to look at input formats and output documents, to understand the flow of work associated with the system, to determine how flexible it is, to judge whether it passes the three tests mentioned previously, and, generally, to learn as much as possible about the responsiveness and reliability of the vendor. The following are some other factors to consider:

- The type, extent, and cost of software support;
- The type and length of warranty;
- User-friendliness--
  - Simplicity,
  - Ease of learning,
  - Ease of use,
  - Menu or command driven,
  - Consistent commands,
  - On-screen help, and
  - On-disk tutorial;
- Quality of user-level documentation;
- Error handling capabilities;
- Flexibility;
- Speed of operation;
- Extent of integration--
  - Internal,
  - With other packages from same vendor, and
  - With software from other vendors;

- o Type, extent, location, and cost of training;
- o Amount of training required;
- o Evaluations from other organizations using the software--
  - Of the software, and
  - Of the vendor;
- o Hardware requirements--
  - Machines or operating system required,
  - Memory and storage requirements, and
  - Single or multi-user.

When a local government fails to develop adequate software specifications or when it conducts software evaluations haphazardly, the results are predictable: software that does not meet expectations; dissatisfied users; excessive cost; lengthy and painful implementation cycles; and, in cases, partial or complete system failure. More detailed evaluation is required of custom-written and packaged software than of off-the-shelf software. But, without some evaluation, it is impossible to tell whether any product meets an organization's requirements. As the television commecial says: "You can pay me now or pay me later." Doing it right the first time is always preferable and usually far less expensive.

**Languages and Programming**

Computer software is written in special codes known as programming languages. Best estimates suggest that several hundred languages have been developed since the first computer was built. For general business and local government microcomputer use, however, three languages deserve particular attention--BASIC, COBOL, and FORTRAN. Three other languages, Pascal, FORTH, and C, are also used on microcomputers, but they are generally used by programmers to write application software.

BASIC, or Beginner's All-purpose Symbolic Instructional Code, is probably the most widely used language on microcomputers. BASIC and most other commonly known languages are high-level languages. This means that programs written in these languages contains English-like statements--not florid prose but understandable words and phrases.

BASIC is a fairly standard feature with micros and many nonprogrammers have been able to learn BASIC with little or no formal training and to write simple programs. Writing programs in the other high-level languages is more difficult and often requires extensive formal training.

COBOL, standing for **CO**mmon **B**usiness **O**riented **L**anguage, is probably the most widely used language for business-type functions in minicomputers and mainframes. This should not be surprising because it was created exclusively for this purpose. To date, however, COBOL has not been the primary programming language for micros, although its use in application programs is increasing.

FORTRAN, for **FOR**mula **TRAN**slation, is essentially a scientific and engineering language and does a good job with mathematical equations and expressions. Hence, it is widely used where these functions are required, such as in engineering and public works applications.

In addition to programming languages, inquiry, report generating, and database management type programs are even more English-like. Ordinary computer users armed only with a simple book of commands and instructions can operate these programs using standard English commands. No programming skills are required.

Other languages, although not as common as BASIC, FORTRAN, and COBOL, are being seen with increasing frequency on micros. For the local government official, however, the name of the programming language is less important than whether adequate application software is available to run on the micro.

Generally speaking, the more sophisticated the microcomputer, the greater its language capabilities. While 8-bit systems typically are limited to one language, usually some version of BASIC, 16-bit and larger systems may support several languages.

Language capability is important ~~for two reasons. First,~~ if a local government plans to do any of its own programming, it will want a system that either has a language that staff members already know or a language that is relatively easy to learn, such as BASIC. ~~Second, a system's language capability must be known to acquire software written in the correct language. A system that supports only BASIC will not run programs written in COBOL and vice versa.~~

Another important consideration regarding programming languages, especially BASIC, is whether the program is **interpreted** or **compiled.** Computers understand instructions that are written in **machine language** or **binary**; that is, strings of 1's and 0's. High-level languages such as BASIC allow the user to instruct the computer using a language that looks more like English. Then, another program called an interpreter or a compiler, translates instructions into language upon which the machine can act.

The major difference between an interpreted and a compiled program is speed. A program is made up of many statements, each one describes a particular function that the computer must perform. Statements in an interpreted program are read, translated, and carried out one at a time. This process is repeated each time the program is run.

A compiler, on the other hand, translates the entire program into machine language, produces what is known as object code (or the symbols the machine understands), and stores the object code on disk. Because the entire program is translated once, the program runs much faster, 10 to 30 times faster than interpreted programs according to one source.[22]

**Processing Modes**

When compared with the state-of-the-art in commercially available microcomputers, earlier generations of computer technology appear surprisingly primitive. Earlier generation systems typically were **batch-oriented.** A user would execute a series of coded forms, a keypunch operator would turn these forms into a deck of punched cards, and then the cards would be delivered to the computer center where they would be processed. Sometime later a printed report would be produced. Several batch activities could occur simultaneously on larger computers, but only a single application could be performed on smaller systems at any time.

While the batch processing of activities such as billing or payroll is not uncommon in current systems, modern technology encourages a different kind of system use. This can be defined as on-line, real time, interactive, and multi-tasking (or multi-programming). Modern systems are also referred to as user-friendly.

**On-line** means that the computer's peripheral devices, such as the video monitors, printers, modems, and disk or tape drives, are physically connected to the computer. **Off-line**, then, means that a device is not physically linked to the computer.

**Real time** means that processing is accomplished immediately upon command by a user. This contrasts with an earlier generation machine where a user would deliver coded sheets or punch cards to a central data processing location and wait several hours or even days before seeing any results. It also contrasts with batch software for real-time machines where a user will input data in real time but the software will not complete the processing activity (for example, perform calculations or update all affected files) until later.

**Interactive** means that a computer user, sitting at a monitor and using the system's keyboard, mouse, or other input device, can enter, revise, or delete data, and give commands to the system while communicating directly with the computer. This is direct human-machine interaction.

**Multitasking** means that, because of its incredible speed, the computer's CPU appears to be performing several tasks simultaneously. For example, one user might enter billing data via a monitor, another might update accounts receivable records, a third might inquire into the status of a budgetary account, all the while the printer is running a detailed report on equipment maintenance. In this case, several users ~~programs~~ are operating several programs on the system at the same time ~~by several users.~~

A major difference among types of microcomputers exists in the area of multitasking. Multitasking capability is lacking in 8-bit microcomputers; they are essentially single user, single function systems. Some, although not all, 16- and 32-bit micros, have multitasking capabilities. Multitasking should not be confused with **multiprocessing.** Multiprocessing is where two or more CPU's are connected together.

Multitasking can also be confused with **multiuser.** A machine does not need to have multitasking capability to be part of a multiuser system. For example, several micros on a local area network constitute a multiuser system but each of the micros may be a single-user device. The reverse is also possible. For example, an IBM PC AT or compatible, operating under the MS DOS operating system, is a multitasking machine being used as a single user device. A true multitasking machine is one with a CPU capable of supporting the simultaneous performace of multiple tasks conducted by multiple users.

A **user-friendly** system is one that can be used by persons who have little or no background or training in computer technology or programming. In this case, a payroll clerk might enter all necessary data and all commands necessary to the computer to ensure that a payroll is made and all accounting is recorded properly. The payroll clerk knows how to make a payroll but may know little or nothing about computers and programming.

User friendliness is not a property of computer hardware; it is a software function. User-friendly software instructs users, provides them with choices of actions to take (often in the form of sequenced lists or multilayer menus), ensures that illegal actions cannot be taken, and forgives mistakes.

For example, a payroll clerk might see a **menu** (or list of choices) on the CRT. The menu provides several choices, asking for instance whether to (1) **create a record**, (2) **update a record**, or (3) **delete a record.** If the clerk answers (1), a second menu providing choices of actions for record creation will appear and so on until actual data entry to create the record begins. Furthermore, only legal entries are allowed. Hence, an address cannot be entered for a Social Security number, and, if a mistake is made, the software tells the user and allows for instant corrections.

User-friendly is a term that almost all software vendors attach to their products. But, here again, buyers should beware and be wary. Not all user-friendly programming is equally so and, in the final analysis, whether a program is user-friendly is decided by the user not the seller. So, sit down at a machine and use the software until you are comfortable with it and are satisfied that it will do what you want, how you want, and when you want before you buy it.

# CHAPTER V -- COMMUNICATION

Today, most microcomputers in public organizations are used as stand-alone, single-user devices. This is true regardless of whether they are 8- or 16-bit or larger machines. Furthermore, most communication involving micros is relatively straightforward; micros are used as terminals to larger computers and to access remote databases and electronic networks.

Data communication involves sending and receiving information (often in the form of entire files) between computers. It enables users to share data, information, software, and peripheral devices; to create and update files stored on other computers; to access information from remote databases; and to send and receive messages.

The reasons organizations need to communicate affect the types of communication methods they choose. This, in turn, affects the type of hardware and software that must be added to the micro (and sometimes to the host computer) to enable it to communicate. Micros can be used in data communication (1) as terminal links to mainframes and minicomputers; (2) in networks of microcomputers; and (3) to access remote databases, networks, bulletin boards, and electronic messaging facilities. The following pages provide a brief, nontechnical overview of these communication modes, their hardware and software requirements, and some of their strengths and limitations.

## Micro-to-Mainframe Communication

Micros can be used either as dumb or intelligent terminals to mainframe or minicomputer **host** systems. As a dumb terminal, the micro has the same applicability and capability as a standard CRT--to enter data and use software on the host. As simple as it sounds, this can involve fairly sophisticated activities, such as creating, updating, and deleting records and files, ordering processing activities, printing, and inquiring into databases on the host.

Use of a micro as an intelligent terminal means that the micro can **download** or receive and store data from the host, use those data with software resident on the micro, **upload** or transmit entire files to the host, print data on the micro's printer, and take other actions that use the local processing power or intelligence of the micro.

Micros can be linked to host computers either by direct cable connection or via telephone, using a modem. In either case, they will need terminal emulation hardware and software. **Terminal emulation** enables the micro to appear to the host as one of its authorized terminals. This is important because host computers can only understand data transmitted according to recognizable protocols established by the host manufacturer. To communicate with a DEC (Digital Equipment Corporation) minicomputer, for example, a micro must look as if it were a DEC terminal. To communicate with an IBM mainframe, a micro must look as if it were an IBM terminal. The same is true for communication with other mainframes and minicomputers. Terminal emulation hardware and software on the micro enables it to send and receive data in a way that the host understands. A common emulation standard for DEC minicomputers is the DEC VT100 terminal. For IBM mainframes, it is the IBM 3270 terminal. Other manufacturers have their own standards. Many terminal emulation devices let the user select which standard to use and to switch among standards as needed.

Micros and most minicomputers understand data that are coded in the **ASCII** (American Standard Code for Information Interchange) format. IBM and compatible mainframe computers understand data that are coded in the **EBCDIC** (Extended Binary-Coded Decimal Interchange Code) format. Among other things, a 3270 terminal emulation package translates ASCII characters into EBCDIC and vice versa. Without such a code translation micros cannot communicate with IBM mainframes.

Another important aspect of communication is whether data are transmitted asynchronously or synchronously. **Asynchronous** means data are sent continuously, one character at a time, and are preceded and followed by start and stop bits that indicate where a character begins and ends. Most micros and minicomputers transmit asynchronously. **Synchronous** means that data are sent in groups of bits and that the sending and receiving devices are synchronized to each other's transmission. Synchronous communication is used by IBM mainframes.

Additionally, data can be transmitted one way at a time, called **simplex**; two ways but with data flowing only one way at a time, called **half-duplex**; and two ways with data flowing both ways simultaneously, called **full-duplex.** Half-duplex is the usual transmission mode for ordinary governmental and business data communication.

Data transmission speed is expressed in bits per second or **BPS.** Common transmission speeds are 300, 1200, 2400, 4800, and 9600 BPS for communication via telephone. Because voice-grade telephone lines are not designed for data communication, transmission speeds greater than 2400 BPS (some experts say 1200 BPS) have a greater likelihood of encountering errors and data losses. Hence, 300, 1200, and 2400 BPS transmission are the most common speeds via telephone. The better modems on the market allow users to select among several transmission rates. They also have the ability to detect certain types of communication errors. As explained in Chapter III, a **modem** is a device that translates the computer's digital signal into an analog signal for transmission over telephone lines. Modems must be installed on sending and receiving computers for them to communicate with one another.

The advantages of using a micro to connect with a host computer are that the micro can be used as a stand-alone personal tool and as a CRT and the user does not have to switch back and forth between two separate devices. In addition, because it has its own intelligence and mass storage capability, the micro can download files and records from the host, can perform processing and printing activities on them locally, and can upload finished work to files and databases on the host. The micro can also use peripherals, such as disk drives, high-speed printers, and other specialized devices, on the host.

The ability to connect a micro with a host computer is especially valuable for periodic access to large organizational databases (for example, land-use data) which will not fit on the limited mass storage system of a micro, to store local data on a large system where access or reports are needed only once or twice a year, and to use the software and processing power of the host computer.

Limitations to this approach are inevitable. The biggest one today is that mainframe and minicomputer software cannot be downloaded to micros. Hence, micro users have to manipulate downloaded data using available microcomputer software. This might involve downloading budget information to a micro, using a microcomputer spreadsheet to prepare budgetary alternatives, and then uploading these to the budget preparation module on the mainframe. While this approach is undoubtedly superior to preparing budgets manually, it can pose difficulties because of differences in file and record structure between the micro and the mainframe. Data may have to be reformatted before they will be usable by receiving machines.

Another limitation is that access to files on the host may be restricted. Access can be limited by restricting entry into a file to only certain users, restricting users to read-only access (a user can view the data and that is all), allowing read-write access (view and change the data), and controlling users' ability to upload and download entire files. Often these restrictions are matters of negotiation with file owners and host system managers and will vary based on considerations such as the user's data needs and system security requirements. For example, land-use planners need access to a community's real property file for a variety of land-use purposes. The real property file in many communities is prepared and maintained by the tax assessor who, understandably, does not want the data in the file damaged or destroyed. Hence, land-use planners and others who need data from this file are allowed to inquire into the file, read and print data, and download information to their micros. They are not allowed to add or change data or to upload information to the file.

**Micro-to-Micro Communication**

Organizations can use micros to communicate with other micros. For example, data stored on a micro in one location can be accessed by a micro (or any other computer) in another location via modem and telephone connection. In this way, the host micro works just like an on-line database. Because of the hardware limitations of micros (speed, single user, and limited storage), organizations should exercise caution when considering micros for such an application. A multi-user micro, mainframe, or minicomputer may be a better choice. However, if the database is manageable in size and the volume and frequency of calls to it are not excessive, it is an inexpensive way of establishing a remote on-line database.

The **Local Area Network (LAN)** is emerging as perhaps the most important method of micro-to-micro communication. Theoretically, at least, LANs enable organizations that own or plan to buy multiple microcomputers to interconnect them to share databases, peripherals (including printers, disk drives, and communication capability), and even software.

Three LAN alternatives exist--**Star**, **Ring**, and **Bus** topologies (see Figures V-1, V-2, and V-3.) A topology is simply a method of configuring a LAN. Under the star topology all equipment on the network is connected to a central device known as a **server.** The server is actually a computer, either another micro or a computer-driven device supplied by the LAN manufacturer. The server routes messages through the system and controls use of system resources, such as a common hard disk drive and printers. The ring network connects micros in a ring, and messages constantly move around the system until they arrive at their destination. The bus topology connects micros on a cable in a linear fashion. The ring and bus topologies may or may not use servers.

Networks can be quite cost-effective for users with expensive peripherals, such as laser printers or large disk drives. They also provide the opportunity to create a multi-user system out of essentially stand-alone devices.

Networks also have several weaknesses. The first is that application software to run on networks is not widely available at this time. Software developers, moreso for off-the-shelf products than packaged local government software, are beginning to develop network packages and, in time, a wider range of application software that runs on networks will become available.

Currently, most organizations must use single-user software on networks, and this can result in problems.

To begin with, a network must have a **network operating system.** The network operating system controls the activities of the network in a manner similar to the way in which operating systems on stand-alone units work. The network operating system also provides the capability for **record and file lock-outs.** This means that, in theory at least, the system can keep two users from entering the same file (not desirable) or from accessing the same record (desirable) simultaneously. Unfortunately, not all application software is written to take advantage of record locking, and, without record locking, a system has little or no protection against data degradation. Suppose, for example, that two clerks enter the utility billing file, access the same customer record, update it, and store the updated record back on disk. Which updated record will the system accept? Which is correct? The absence of record locking can be a serious weakness in many applications.

A second software problem involves copyright protection. Some versions of single-user application software will run on some networks. Users who run such programs on networks and allow multiple copies to be made or allow multiple use of a single package may violate the copyright on the software package. In recent months, software vendors have begun to file lawsuits to stem the tide of copyright violation. The prudent local government will take action to avoid the unnecessary risk of a lawsuit over copyright infringement.

A second set of network limitations involves hardware. These include lack of standardization, network complexity, system performance, and cost. Lack of standardization results because several vendors offer different solutions to networking requirements. Their solutions vary principally in topologies, type of cabling employed to connect devices, type of protocols used to control the way messages are sent on the network, and the way in which peripheral devices are shared. Sorting through the maze of computing technologies and marketing claims can be difficult and time consuming. Moreover, once a technology is chosen, the user has little flexibility in the future.

Networks are complex beasts. A typical network might involve 3 or 4 stand-alone micros, a multi-user micro acting as a server, a hard disk drive, a system printer (perhaps a laser or a fast dot matrix device), dot matrix printers attached to individual micros, and a letter quality printer. These devices are connected with a cable specified by the manufacturer for a particular LAN. Finally, add-on network hardware boards are needed for each micro, and a network operating system oversees the activities of the entire system.

Such a configuration is much more complex and open to more hardware problems than stand-alone units. Some observers believe that networks are inherently more complex than both multi-user micros and minicomputers because of all of the add-on equipment required to enable the network to function. Multi-user capability is built into the system for multi-user micros and minicomputers. To make a multi-user system out of a single-user micro requires added layers of equipment and software and increases the complexity of the system.

Networks tend to be slower than multi-user microcomputer and minicomputer systems. In part, this is because the microprocessors of the network devices are slower and less powerful than those of multi-user micros and minicomputers. Where a CRT or intelligent work station on one of the latter can access or sort through a file on a central disk drive almost instantly, several seconds or even minutes may be required to perform the same tasks on a network.

Some vendors claim almost infinite expandability of their networks ("It will handle up to a zillion PC's!"). The trade literature suggests that realistic limitations on today's networks, for decent performance and response, may be no more than 8 or 10 micros. If carefully selected (beware of the unjustifiable marketing hype here as well), multi-user micros and minicomputers offer greater expansion capability and greater performance.

Cost is another important factor. A LAN may be the only alternative for organizations that have invested in several micros, a laser printer, and other expensive peripherals. Starting over with a multi-user system may not be feasible financially or politically. Still, organizations will face the added costs of cabling, network boards in the range of $400-$600 for each micro, possibly a server or a master work station, a hard disk drive, system installation, and maintenance.

Minicomputers and multi-user micros may be more cost-effective for organizations that can examine alternatives to networks. The best way to determine cost-effectiveness, of course, is to use the process recommended in Chapter VI: determine requirements, bid a system, and evaluate proposals for both performance and cost. Currently, multi-user systems are available that outperform networks and do so at an equivalent or lower price for a similar configuration.[23] Moreover, the cost of expanding a multi-user system is often less than the cost of expanding a network: $500 to $750 per CRT versus $1,500-$2,000 per network work station (micro and expansion board). Of course, need should determine whether a LAN or a true multi-user system is an appropriate solution for any organization, and need should be balanced against cost and performance.

The following are some important considerations for local governments that decide to establish LANs:

- o Can any work station use any peripheral on the system, for example, hard disk drive, printers, expansion boards, and modems?
- o Will different versions of the selected microcomputer operating system (for example, DOS) run on the system?
- o Will the selected application software run on the network? Does it have record-locking capability? Will it work with the network's record-locking scheme? Will current versions of the application software, especially single-user software, run on the network? Will use of single-user software on the network run afoul of copyright laws?
- o What is the speed (theoretical and real) of the network? In particular, this means evaluating the speed of accessing software, data and files from the disk drive, inquiring into and sorting through files, and determining whether the system will slow down noticeably if more work stations are added. How does this performance compare with that of a multi-user micro or minicomputer?
- o Does the network allow print spooling (that is, the ability to store print jobs for later printing and the ability to wait until the printer is free)? Will the network accommodate graphics printing?
- o What are the network's theoretical and real expansion limits, for example, number of work stations and number and type of peripherals?
- o What are the minimum memory requirements for the server (or master work station) and for individual work stations? What is the maximum and recommended memory?
- o What is the maximum hard disk storage capability of the network? How much of this capability is accessible by individual work stations?
- o What is the initial cost of the network, including server (or master work station), individual work stations, network boards, cabling, hard

disk drive, and other peripherals? What is the cost per work station to expand the network? What is the maintenance cost? How do these costs compare with the cost of a multi-user micro or minicomputer?

- o How local is local? Does it mean intra-office, intra-building, or among dispersed sites? How will distance between work stations affect performance?
- o Will the network allow mixing of various brands of micros with various operating systems? If so, how does the network allow them to use peripherals and to share data and software?

**Electronic Messaging and Remote Databases**

Electronic messaging refers to the use of computers to send and receive information electronically, much as we use the postal service to send and receive written or printed material. Electronic messaging can be very useful for busy people who are often out of their offices and who find it difficult to keep up with their telephone messages. The mayor of Omaha, Nebraska, and city department heads use the AGNET computer network (a statewide computer network supported by the University of Nebraska's College of Agriculture) and portable terminals to communicate with one another. The mayor also uses AGNET to communicate with the governor's office. Officials can also take their portable terminals on trips, connect them to a telephone in a hotel room, and receive and send messages to the office.

LOGIN--(Local Government Information Network) is an international computerized network supported by Control Data Corporation. LOGIN contains over 20,000 data units, brief examples of innovative and exemplary governmental practices and other information of value to governmental organizations. These data units are accessible by LOGIN subscribers through a telephone call to Control Data Corporation's Cybernet network. Perhaps a more significant LOGIN capability, however, is electronic mail. Users can question other persons on the network or query one of LOGIN's special interest subnetworks. Over 300 questions are asked per month, and about 75 percent are answered, usually within a few days.

LINUS (Local Information Network for Universal Service) is a more recent network, and one designed specifically for messaging use by local governments. LINUS is sponsored jointly by the International City Management Association (ICMA) and the National League of Cities (NLC) in cooperation with Control Data Corporation.

Users can send messages, ask questions, reply to inquiries, and access information on one of the LINUS bulletin boards for a fee of $0.40 per minute or $24 per hour. All that is required is a micro or a terminal on another computer, and communication capability. Subscribers can reach LINUS via telephone and, depending on their location, this is often a local telephone call.

The principal LINUS features include the following:

- o User-to-user messaging,
- o Access to a dozen or so ICMA and NLC bulletin boards (see Figure V-4),
- o Participation in various special interest groups,
- o Participation in subnets, and
- o Access to a directory of system users.

Figure V-4

LINUS Bulletin Boards

- **Calendar of events:** This lists upcoming ICMA/NLC activities, state league and association events, as well as those of selected other organizations. This includes listings for committee meetings, annual and regional conferences, and training sessions.

- **NLC and ICMA Staff Director:** This bulletin board contains the names, functions, and telephone numbers of staff of the two organizations.

- **Product and Service Information and Ordering:** This provides an integrated listing of products, including publications and services, provided by ICMA and NLC by subject area. It provides users with descriptions of products and includes an order form for ordering products.

- **Special Interest Group Listing:** This bulletin board includes a complete listing of special interest groups available on LINUS, including the name of the group and a brief description of the objectives and activities of the group and its members.

- **Inquiry Bulletin Board:** This bulletin board is planned for the future. It will consist of various topics of interest to local officials, and they will be able to query their colleagues as to their practices or knowledge in an area.

- **Urban Action Update:** This bulletin board contains the status of Congressional bills that NLC is following. Posting will be by NLC only.

- **Congressional Directory:** This NLC bulletin board contains the membership of each House and Senate committee.

- **NLC Policy Committees:** This bulletin board includes a list of the membership, policy areas, and meeting dates for the NLC steering committees that help define and recommend NLC national municipal policies.

- **ICMA Job Listings:** This provides the ICMA job listings also found in the ICMA newsletter. Users are able to search the job listings by categories, such as region, salary range, or job title.

- **ICMA Job Appointments:** This includes an up-to-date, cross-referenced listing of recent appointments to local government management positions.

- **MIS Inquiry Form:** This is an on-line form for management information service subscribers to request ICMA staff research inquiries.

- **Nuts and Bolts:** This ICMA bulletin board includes a semimonthly summary of management techniques and projects being used by local officials.

Virtually every major sector of the economy has access to electronic databases--lawyers, doctors, stock brokers, chemists, librarians, and college professors. In addition to LOGIN and LINUS, local governments can access these other databases should they be of interest. An organization must own a micro or other computer, a modem, and a telephone and it must subscribe to a network, such as Dialogue, the Source, or CompuServe. Depending on the network selected, a user may have access to several hundred databases.

Remote databases can be especially helpful to users who are searching for specific information. For example, in preparing to revise this manuscript, I asked our university library to search on-line bibliographic databases for recent books and articles about microcomputer use by governmental organizations. Data processing directors can use LOGIN to search for information about how other cities and counties are using computers, and public works directors can ask questions about how other cities collect garbage or patch potholes. City attorneys can search LEXIS and WESTLAW (two legal databases) to uncover the latest court rulings on subjects such as housing, affirmative action, and liability. Wastewater system directors can search chemical databases for reports concerning the effects of various chemicals on sewage treatment facilities.

On-line databases can be valuable because they provide instant access to large volumes of information. But, they can be costly too. At $40 per hour, fairly typical daytime rates, two or three avid users in a local government can easily run up substantial bills.

As with other aspects of computing, need should determine whether a capability is acquired. Data communication can add layers of complexity and cost to otherwise simple and relatively inexpensive stand-alone micros, but it can also provide users with added capabilities. Wise purchasers will balance these capabilities against their costs and then decide whether data communication is an appropriate solution to their information management needs.

# CHAPTER VI -- PROCUREMENT GUIDELINES

Local government personnel are assaulted as well as insulted by sales pitches to buy micros. They are told that computers can do almost anything, and can do it faster, smarter, and cheaper.

Much of the information about micros is written to sell equipment or for articles in the popular media. Very little is based on research on the actual uses of microcomputers and their effects on society. Marketing literature and popular reporting provide scant help to the person or organization considering a microcomputer. A decision to acquire a microcomputer system requires a well-considered, systematic approach that must be followed carefully and completely.

The method recommended in this book for microcomputer system procurement is not very different from the method that should be used in the acquisition of any goods or services by a governmental organization. This method has been used successfully in the acquisition of larger computer systems by local governments around the nation, and its use in microcomputer procurement has been demonstrated successfully in small local governments in Nebraska.[24]

## Procurement Steps

The procurement method recommended here resembles a straightforward problem-solving exercise which consists of identification of the problem, identification and examination of alternative solutions, selection of the most feasible solution, and implementation of the solution. The procurement method for microcomputers is somewhat more complex and involves seven steps: (1) determining requirements, (2) establishing feasibility, (3) preparing an RFP, (4) evaluating proposals, (5) selecting a system, (6) negotiating a contract, and (7) implementing and monitoring the system.

**Determining requirements.** Acquiring a computer system is not a technical issue. Certainly several of the activities and much of the information required are technical in nature, but system acquisition is fundamentally a management issue.

Local governmental officials regularly make decisions to allocate resources to accomplish the work of their organizations. Computer system acquisition is just another set of resource allocation decisions. The same principles associated with resource allocation and problem-solving in other activities apply.

The first question to ask when considering purchasing a microcomputer is whether the governmental organization really needs one. To answer this question, governmental personnel must determine the computing and management information requirements of their organizations. A requirements analysis will help establish the basis of need for a computer system and will allow personnel to make decisions regarding computer type and size.

Management information requirements are not created out of thin air, and they do not come from computer system vendors. Never ask a vendor to define the managment information needs of a local government. Vendor representatives know computer sales and the capabilities of their particular brands of hardware or software, but they do not know the computing and information requirements of a particular organization. Vendor-defined information requirements will almost always resemble systems available from the vendor. The same can be said for requirements analyses developed by consultants whose firms also sell computer systems or software.

Management INFORMATION requirements are defined as the result of detailed analysis. Local government managers can perform a requirements analysis using local staff resources, or they can request consulting assistance. Either way, careful analysis is required, and the result should be a clear statement of the organization's computing and information management needs. Even if a government ultimately decides not to acquire a microcomputer system, it will at least have gone through a valuable exercise and will have developed a set of information requirements against which to revise manual systems and make them more efficient. The statement of the organization's information needs should identify as specifically as possible the information that local government personnel need to perform their jobs properly.

Figure VI-1 contains a statement of management information requirements that was developed by an interdepartmental task force of a midwestern city for vehicle and equipment management. These are the information items that managers felt they needed to do their jobs. They are stated functionally so that computer system vendors will be able to decide how their hardware and software will best meet the buyers' needs and so that managers will know what they are getting.

These requirements probably do not represent the functional requirements for equipment management for all communities. Neither do the requirements for an automated financial management system that are contained in Chapter IV. However, they should provide at least a basic understanding of management information requirements for two major functional areas in local government.

**Establishing feasibility.** The second step in the process of acquiring a microcomputer is to determine whether a micro is feasible technically, financially, and politically. Computerization is technically feasible in local government for a range of functions. Today, micros are found in most local government departments and are used to perform many activities.

Figure VI-1

INFORMATION MANAGEMENT REQUIREMENTS FOR AN EQUIPMENT MANAGEMENT SYSTEM

Equipment:

- Detailed description of all vehicles and equipment,
- Equipment status and condition reports,
- Depreciation schedule,
- Equipment assignment (location/staff), and
- Equipment specifications.

Maintenance:

- Records of all repairs (preventive, maintenance, emergency, vendor, and warranty),
- Twelve-month history (on-line),
- Equipment life history (on tape),
- Billing to departments, and
- Preventive maintenance scheduling.

Parts Inventory and Control:

- Detailed parts inventory,
- Integration of inventory with purchasing system,
- Critical reorder parameters,
- Parts control (receipt, issuance, charging, transfer, and return), and
- Handling of both used and new parts.

Work Orders:

- Labor and parts, and
- Updating of equipment, maintenance, parts, and performance evaluation files.

Fuel Inventory and Control:

- Inventory status for all fuel dispensing stations,
- Fuel dispensing records,
- Fuel use by vehicle, and
- Integration of fuel inventory with purchasing system critical reorder parameters.

Productivity/Performance Auditing:

- Performance standards, and
- Performance reports (actual vs. performance standards, by type of activity, by repair facility, and by employee).

Although acquisition of a microcomputer is a management rather than a technical issue, technical questions arise during several aspects of a procurement exercise. Examples of these issues include memory size; amount and type of mass storage; number and type of peripheral devices; centralized or distributed processing; 8-, 16-, or 32-bit system; single or multi-user system; and type of communication capability needed. These technical questions are related directly to the agency's management information requirements and to the volumes and frequencies of its activities.

**Volumes and frequencies** are important to the sizing of the system. In the example of the equipment management system, they include the number and type of vehicles and other equipment, length of the inventory records, the frequency of the transactions that create and maintain records on the system, and the frequency of inquiry and reporting, among others. Volume and frequency data for all functional areas or activities to be automated must be gathered during the information management requirements analysis. These data must also be provided to prospective vendors as part of the request for bid or proposal so that they can respond with an appropriately configured system. Vendors must also be told the extent to which the volume of files, records, and historical information and the frequency of transactions will remain stable, decrease, or increase during the expected life of the system.

In many communities, financial and political feasibility are more significant than technical issues. Financial and political feasibility touch on whether a local government can afford a computer system and whether local officials and staff will support automation.

Some form of cost-benefit analysis should be used so that decisionmakers will know how much the system is likely to cost. Naturally, an objective analysis is required. Total system costs should be identified both for initial installation and for continued operation. These data are essential in any system acquisition.

Total system costs include at least the following:

- o All hardware for the initial system configuration (for example, CPU, monitors, disk drives, printers, modems, cables, and any other equipment needed to make the system function at an acceptable level);
- o Operating system;
- o Application programs, whether off-the-shelf or packaged, or the cost of program development and the cost of any required modifications;
- o Training, including costs of travel and subsistence if training is provided off-site;
- o Hardware maintenance;
- o Software support;
- o Supplies (for example, paper, ribbons, and disks);
- o Electrical (for example, power supply) or room modifications;
- o Additional furniture (for example, desks and tables to hold this equipment); and
- o Conversion of data from current systems and methods to the microcomputer.

These costs should be totalled and projected for one-year and either three- or five-year periods to provide a clear picture of both initial and system life costs. Governments that own antiquated computer systems, such as bookkeeping machines and older mini- and microcomputers, may find that the system life costs of a new microcomputer system may compare very favorably and that the new system will provide substantially enhanced capabilities. In cases where the government will be a first-time purchaser of computer technology or will acquire a micro as an additional piece of equipment, out-of-pocket costs can be expected to be greater than current costs, but the functional benefits and capabilities of the micro may more than outweigh the monetary costs.

Determining cost-effectiveness may be the most difficult part of the procurement effort. Indeed, many local governments have decided to treat the purchase of individual, stand-alone micros just as they treat the purchase of other types of office equipment. If it can be justified functionally (for example, to improve the performance of one or more activities) and a department has money in its budget, it may purchase a micro.

Cost-benefit analysis alone may be insufficient to establish the feasibility of buying microcomputers. In more than one example, analyses have shown that over a five-year period, a new computer system could be financed out of actual cost savings. Yet, after lengthy consideration, city decisionmakers have either scaled down the systems considerably, delayed their purchase, or killed the acquisition completely. This can occur because elected officials may view the initial expenditure as politically unjustifiable. It can also occur because of lack of communication between staff and elected officials to demonstrate to the latter why computerization is needed or beneficial.

No guaranteed method exists to ensure the political feasibility of procuring a computer system, but several measures can be taken to facilitate it. They include a sound requirements analysis; objective cost-benefit analysis; and open, honest communication between key staff persons and elected officials.

Communication is critical throughout the process because it promotes understanding of the need, costs, and impacts of automation. Understanding, of course, does not necessarily result in support, but, at the minimum, it provides all participants with a common framework and promotes educated decisionmaking.

In many communities, a committee of elected officials and key staff persons is established to participate throughout the procurement process. These persons help determine management information requirements and review all other elements of the process. This helps committee members to understand the procurement process and to appreciate the need (if there is one) for the system. This knowledge can be communicated to the government's governing board when the time comes to decide whether to acquire a microcomputer system.

In smaller communities, such a committee may make especially good sense because spending $15,000 or $40,000 for a multi-user microcomputer system or acquiring several stand-alone devices may be considered a major purchase. In larger governments, on the other hand, purchases of this size are fairly routine. Yet, in larger communities, other issues may be important, including compatibility of systems, proliferation of micros, and competition with the mainframe. Here, a clear organizational policy on micros may be helpful. I discuss such a policy in Chapter VII.

Once a local government initiates a microcomputer system procurement process, it must decide what type of software to acquire and how to acquire it. I discuss software in detail in Chapter IV, and that discussion will not be repeated here. However, the buyer should keep foremost in mind that software is the key to a computer system. Without software, the box just sits there and does nothing.

**Preparing a request for bid or proposal.** When a local government's desire for a computer system becomes known, numerous marketing calls and unsolicited proposals from vendors often result. Furthermore, almost every vendor knows what the local government needs, has products to meet those precise needs, and has only the interests of the local government at heart. Confusion can easily set in after listening to half a dozen or so of these marketing calls. Sometimes, local governments buy computer systems on the basis of unsolicited proposals. Those that do are asking for trouble. Among other things, they have allowed a vendor, who has a distinct financial interest in the outcome, to define their computing needs.

A well-written RFP (request for proposal or request for bid) that is based on an objective requirements analysis, on the other hand, will help to ensure an effective and efficient procurement of a microcomputer system. A formal RFP process is especially helpful when considering the purchase of a multi-user system or a large number of stand-alone units and for establishing the bid standard for both immediate and future microcomputer purchases. An RFP should contain at least the following information:

- General bid conditions--

  Bid deadline,

  Procurement decisionmaking schedule,

  Contact person's name and telephone number,

  Bonding requirements (bid and performance),

  Local government rights and prerogatives,

  Insurance requirements,

  Delivery and system implementation requirements,

  Maintenance and support requirements,

  Local government's sample contract, and

  Unique legal requirements.

- Bid format--

  Vendor information,

  Customer/user reference list,

  Software and software support,

  Hardware and hardware maintenance,

  Operating system and languages, and

  Facility requirements.

- General system requirements--

  Personnel considerations,

  File protection and backup,

  System adequacy,

  Modularity,

  Training, and

  Documentation.

- Hardware requirements--

  Operating and use mode (for example, on line, real time, and multi-user),

  CPU

  Storage (on-line and off-line),

  Back-up,

  Printers,

  Monitors,

  Other devices, and

  Unique requirements (for example, communication).

The RFP should not tell vendors how much memory or storage is required. Instead, provide the vendors with ample information about the volumes and frequencies of your activities and require them to configure the system. Then make sure that the vendor is contractually responsible for system adequacy.

- Application software requirements--

  This is a list of required application software systems, in order of importance or implementation priority. Each system should be described functionally and in adequate detail and should include the functions the organization must perform and the required manner of performance. Local or state legal requirements for particular applications, such as accounting, must also be included.

- Local government information--

  Name/location,

  Type/form of government,

  Population,

  Current annual budget,

  Number of budgetary funds,

  Number of employees,

  Number of files and records in each application area,

  Frequency of transactions in each application area,

  Historical/archival data requirements, and

  Current automation.

Other information, as may be required by law or may be applicable according to local circumstances or requirements, should be included in the RFP. These might include noncollusion affidavits, alternate bid arrangements, a schematic layout of the required system, and affirmative action/equal employment opportunity statements. Also, standard forms that are required for use by vendors must be included, and it is a good idea to include the locality's standard purchase contract or at least to describe its major features.

Now, this sounds like a great deal to require if an organization is buying one or a few stand-alone micros. It is. Indeed, the development and submittal of a detailed RFP may be neither desirable nor practical in all cases.

In some governmental organizations, policies exist regarding the types of micros that can be purchased while in others, the amount of money to be spent on a micro does not justify the use of an elaborate RFP procedure. Even in these instances, however, the organization's computing and information management requirements should be determined before proceeding. Why is a micro needed? How will it be used? Who will use it? What software is required. These requirements should be matched carefully with the hardware and software capabilities of the systems under investigation and systematic comparative shopping should be undertaken before a purchase is made to ensure acquisition of the best system at the best price.

Figure VI-2 contains a sample set of hardware specifications for a stand-alone microcomputer. These specifications were developed by the Management Information Systems Director of the city of Omaha, Nebraska, for use in that city. For governmental agencies and units **with in-house data processing**

**expertise that have determined their information management requirements,** these specifications, or a modified version of them, can serve as an abbreviated form of a request for bid or proposal and are a sound alternative to the lengthier, more detailed procurement method discussed in this book. Note that these specifications address hardware, a widely used operating system, and the capability of the system to run off-the-shelf software. Programming written for local governmental functions is not specified.

Finally, providing standard forms with these specifications is advisable so that vendors are required to provide information in a uniform format. The use of (VI-2) standard forms promotes easier analysis of bids and proposals.

DENNIS ⇒ FIG VI-2 GOES ABOUT HERE

**Evaluating responses.** Once the submittal deadline arrives, no further proposals should be received, and the formal evaluation process should begin. Knowledge of computer technology is essential during the evaluation to determine whether proposed systems are technically adequate and to ensure that proposals are comparable.

Once bids have arrived, they should be subjected to careful, objective evaluation. Several elements of the proposals should be scrutinized. These include:

- RFP requirements--Did the proposal meet all RFP requirements? Did all vendors adequately complete the standard forms supplied in the RFP? Were all questions answered fully and satisfactorily? Were all required application programs bid? Were the specified operating system and language capabilities bid? Many other questions will arise. If all requirements were not met, can a bid or proposal be accepted anyway? Did the RFP allow the local government to waive technicalities and informalities and accept what it deems to be the best bid?

Figure VI-2

SPECIFICATIONS FOR A MICROCOMPUTER

All features must be available and demonstrable at the time of the bid submission. Contact ____________ for additional information.

## I. Basic Hardware

One (1) microcomputer with the following features:

- 16-bit processor,
- 256,000-character random access memory,
- Minimum of one (1) standard parallel and two (2) RS 232C serial interfaces,
- Internal clock/calendar,and
- Dot-addressable graphics capability.

One (1) 5-1/4 inch floppy disk drive with minimum storage capacity of 320K formatted.

One (1) box of 10 5-1/4 inch floppy diskettes.

One (1) fixed disk Winchester drive with controller having a minimum formatted storage capacity of 10 MB.

Hardware and software necessary to provide a method for backing up the fixed disk Winchester drive (minimum 10 MB formatted capacity) in less than 10 minutes with minimal operator intervention.

One (1) 12-inch or larger color display with dot addressable graphics having a minimum resolution of 640 pixels horizontally and 400 pixels vertically.

One (1) full function QWERTY typewriter style keyboard with 83 or more keys, including a numeric keypad.

One (1) dot matrix printer with data processing and correspondence quality printing capability and the following features:

- 132 column at 10-character pitch,
- Six or eight lines per inch vertical spacing,
- Dot-addressable graphics, and
- Minimum speed 120 cps in data processing mode and 40 cps in correspondence mode.

One (1) line surge protector to guard equipment from variations in power supply.

## II. Basic Software

One (1) MS DOS release ~~2.0~~ 3.0 or later operating system.

## III. System Requirements

System must run using the MS DOS release 2.0 or later operating system and be able to support SNA/SDLC data communications.

Figure VI-2 (continued)

System must be able to run the following general use software: Lotus 1-2-3, Multiplan, WordStar, dBASE II, TIM3, pfs:File, and pfs:Report.

## IV. Other Requirements

Vendor must provide installation of equipment.

A 90-day warranty must be available for all hardware devices.

Hardware maintenance must be available on a local basis with the following options:

Carry-in service (by annual fee and by time and material)
On-site service (by annual fee and by time and material)

Maintenance cost must be provided by component if available.

Delivery must be made within 30 days of bid award.

Vendor must provide a minimum of ____ hours on-site training for all equipment devices and ___ hours for each software package.

## V. Pricing Information

Purchase prices must be provided by system component.

Prices must include freight, installation, cables, operating system software, that is, everything to make the system operational.

- o Hardware--Were all hardware elements proposed? According to unbiased technical reports, is the hardware reliable? Is the hardware configuration adequate for the organization's computing requirements, especially CPU memory and disk storage? What about communication capabilities?

- o System expandability--Can the hardware be expanded to meet the organization's growth requirements by adding additional increments of memory, disk storage, and peripherals? Does it have an adequate number of expansion slots? Will it accept additional operating systems and programming languages?

- o Hardware maintenance--What type of hardware maintenance is available (for example, on-site, drive-in, or mail-in)? Are replacement devices available for use when a particular hardware element needs repair? What type and length of hardware warranty is offered for each piece of hardware?

- o Software support--What type, if any, of support for the application software is proposed (for example, on-site or telephone) and for how long? Is software support needed for any of the software packages? What type and length of software warranty is provided?

- o Vendor organization--What is known about the vendor organization--its size, length of time in the microcomputer business, financial health, number of personnel, reputation, reliability, number of similar installations, experience in the governmental marketplace, and availability of personnel to install and support the system?

- o User references--What experiences have other users, especially other governmental organizations, had with the hardware and software? What do they have to say about the vendor organization?

- o Additional capabilities--What other capabilities are available with the system or from the vendor that may be required (for example, additional packaged or off-the-shelf software or programming capabilities) in the future?

- o Cost--What is the **total cost** of a proposal relative to other proposals, including both initial hardware, software, supplies, support costs, and operational costs for a five-year period? How do the costs of the proposals compare with one another?

Naturally, many persons will ask where to get the information necessary to perform proposal evaluation. Some local governments will find that they need a consultant or other technical advisor at this stage of the procurement process, if not before. Later in this chapter, sources of consulting and technical assistance are discussed. Sources of information are available for governments that decide they do not require consulting and technical assistance. Evaluations of hardware and off-the-shelf software are provided by a variety of publications. These include periodicals such as, PC Week, PC World, Infoworld, Computerworld, Byte, Popular Computing, Consumer Reports, and many others. DataPro Research Corporation and other organizations publish comprehensive directories of computer hardware and software that provide invaluable information for evaluating systems. Beginning with the 1986 issue, the annual Public Works Manual will contain a section on microcomputers that will list software vendors for various public works applications. The International City Management Association, with assistance from the W. K. Kellogg Foundation, will begin publishing evaluations of packaged software for local government activities in 1987.

Local government personnel should visit vendors to see and use proposed systems. They should also visit local governments and other organizations that are using the proposed systems. Vendor proposals, telephone conversations with users, and unbiased technical reports are essential elements in the procurement process. Vendor demonstrations of equipment and software are also helpful, but nothing should substitute for seeing a comparable system running on actual data in a real local government.

**Selecting a system.** At the conclusion of the evaluation, at least the two top systems should be recommended to the governing body or the procurement authority. These systems should be the organization's preferred choices, after the evaluation. Negotiations should be initiated for the system that ranked first with the approval of the governing body or the procurement authority. In the event that negotiations with this vendor fail to produce a satisfactory agreement, discussions should begin with the second choice.

Now is the appropriate time in the procurement process to raise the issue of which system is best. Best is defined as the system that most closely meets the requirements of the RFP, based on cost, vendor reliability, service, software capability, hardware performance, and other criteria. In other words, best is a relative term and must be viewed in the full context of the procurement process, including the requirements analysis, RFP, evaluation criteria, and the local government's needs and its budget for data processing.

**Negotiating a contract.** Signing a vendor's standard contract is rarely a good idea. To do so is to sign a document written by the vendor for the vendor's convenience and protection. A local instrument, created to ensure a local convenience and protection, is preferable.

However, in the microcomputer marketplace, use of a locally written contract may be difficult. The reasons for this--in contrast to the purchase of minicomputer and mainframe systems--are (1) the cost of microcomputer hardware and software and the profit margin for vendors are relatively low; hence, fewer incentives exist for vendors to spend the time and money to negotiate locally written contracts that purchases of larger systems encourage; (2) much of the software for micros is the inexpensive, off-the-shelf variety that is produced in large quantities for a mass market, and, again, vendors lack the incentive to negotiate locally based contracts; (3) many microcomputer sales organizations handle hardware and off-the-shelf software purchases with standard terms and sales agreements which they are unlikely to change; and (4) as a general rule, most microcomputer hardware and software are highly reliable.

Thus, microcomputer systems can be treated like other purchases with which local governments have ample experience, such as office equipment and motor vehicles. In these cases, the use of a vendor's standard purchase instrument or some reasonable version thereof, with modifications as required by local ordinance or state law, is a relatively standard practice, particularly if other steps in a sound procurement process have been followed.

The low cost and high reliability of microcomputer systems also means that their purchase exposes a local government to less risk than the purchase of mainframe and minicomputer systems. This is another reason to place less value on a locally developed purchase contract.

However, where a locally written contract can be negotiated (for example, with a turnkey micro system vendor or as the result of a large-scale purchase of several systems), officials should attempt to do so. The most important aspect of a procurement contract for a microcomputer system is performance. The contract should establish clear performance criteria and provide for system acceptance only after the system consistently meets these standards over a reasonable period of time. Then, and only then, should payment be made. An example of a performance standard might be requiring no software failures and CPU up-time effectiveness of 98 percent or better over a 30-day period of continuous run time, using actual data. Placing additional standards in the contract, of course, is a good idea.

Linking payment to performance is neither new nor radical. It is, however, fundamentally important. Unless a local government establishes and uses performance standards, it will be in a weak position to demand corrective action in the event the system does not work. Adequate remedies, such as liquidated damages and requirements to repair or replace, should be in the contract, and the local government must insist that any lawsuits arising out of the contract be tried in local courts, not in the courts of some distant state in which the vendor's headquarters is located.

A sample contract for the purchase of microcomputer software is included in the appendix. This contract, incidentally, was developed by a software vendor. Key sections of this contract are numbered X and XI; they guarantee the adequacy of hardware to run purchased programs (and associated data) and guarantee user satisfaction.

**Implementing a system and monitor performance.** Typically, system implementation begins with hardware delivery. The system should be uncrated, connected, plugged in, turned on, and left on. The system should be used for a few hours each day for a month or so to make sure all of the hardware is in working order. This is called the **burn-in** period. Chances are if an element is going to fail it will do so relatively soon.

Second, various elements of programming should be installed incrementally, preferably in some logical order, such as the general ledger system first, then payroll, then utility billing, and so on.

Third, during application program installation, user personnel should receive vendor-provided **training** in all program areas, as well as in operating the hardware. Beware of the vendor (or anyone else) who asserts that a couple of hours of training for off-the-shelf programs and a day or two for packaged applications will be sufficient. A good test of the adequacy of a training program is to require a guarantee from the provider that it will enable users to operate the hardware and the application software effectively. If the training is inadequate, then the provider should be obligated contractually to provide needed additional training at no cost.

Fourth, **data files** must be created for all application programs either by manual input or by converting electronically encoded data from other computer systems. This may be the single most difficult and time-consuming part of system implementation. It can also be costly, and this cost is rarely figured into the total cost of acquiring a computer system.

Fifth, after completing steps one through four, the user may begin **running programs** on the system. During the first month or two, **operating in parallel** (running both the old and the new systems to make sure that all elements of the new system work properly) may be necessary. Parallel operation is highly recommended for complex packaged applications, such as general ledger and payroll, but it is probably unnecessary when using off-the-shelf programs.

Finally, system **performance must be monitored** and contractual procedures must be followed. One city, using a locally developed performance-based contract, paid for its system prior to completion of acceptance testing. The system failed to perform adequately, and the city spent months haggling with the vendor for a remedy.

Performance monitoring means making sure that hardware and software are delivered on time, that the hardware functions without failure, that the software performs all required functions, that adequate memory and storage are available for processing, and that staff training and software documentation are provided. In other words, for an agreed upon value, the vendor performs all required tasks and the system performs all required functions.

It is a good idea for buyers to develop an **implementation plan** for large-scale purchases and for installing multi-user systems. The following are some of the considerations to be included in an implementation plan:

- Select a system (or implementation) coordinator;
- Establish the coordinator's role (authority and responsibilities);
- Prepare work station locations and other facilities (room, electrical modifications, and furniture);
- Determine data conversion requirements;
- Establish operating and backup procedures;
- Establish a schedule for hardware and software installation;
- Determine training requirements (by class of employee);
- Provide training (on hardware and software, appropriate to needs of various classes of users); and
- Order supplies (forms, cardstock, paper, ribbons, diskettes, and tape cartridges).

These and other appropriate elements of an implementation plan should be written. Then responsibility for each element should be assigned to specific personnel and starting and completion dates should be assigned to each task. Finally, the coordinator should be responsible for implementing the plan in a timely and effective fashion.

**Microcomputer Sales and Support**

Several sources are available from which local governments can purchase microcomputer systems. These include companies that specialize in microcomputer sales, discount chains, department stores, audio and video stores, farm co-ops, and system manufacturers. Systems can also be purchased through mail-order catalogs.

Local governments can buy both hardware and software from the same organization or they can buy hardware at one place and software at another. Unless a complete system, including hardware and software, is acquired, however, the microcomputer will be less than useful.

Important differences exist among the types of organizations that sell microcomputers. Department stores, discount chains, and audio and video shops, for example, are not primarily in the business of selling micros. Therefore, they cannot be expected to be highly knowledgeable about micros, to sell a wide range of hardware or software, or to be able to provide extensive hardware maintenance or software support. Many of these organizations also sell only home computers or low-end business systems, typically 8-bit or small 16-bit micros with limited memory, few peripheral devices, and software that is aimed at the home user market.

Companies that specialize in microcomputer sales--often microcomputer stores--tend to focus their efforts on small businesses. The systems they offer usually can be configured with ample memory and disk storage capacity for such organizations and will support several peripheral devices (disk drives, monitors, printers, tape drives, and modems) and programming needed for business applications. Many microcomputer stores offer training in system installation, operation, and the use of application programming. To one degree or another, they also offer continuing software support and will either provide hardware maintenance directly or arrange for maintenance with a service organization.

One major limitation of microcomputer stores is their lack of knowledge about the data processing requirements of local governments. They can be a good source for hardware and off-the-shelf software, but they probably will not have the specialized software to meet local governments' needs. However, much of the programming that is sold for standard business purposes can be used effectively without modification, for example, word processing, inventory, paryroll, spreadsheet, and database management software.

Another item to consider is the variability of knowledge among salespeople. Some microcomputer salespersons are highly knowledgeable about their products and those of their competitors; others are not. Also, the conscientious consumer will remember that making a sale is what motivates salespersons. This is how they earn a living, and, while that is understandable, such a motivation may not result in complete or unbiased responses to a prospective purchaser's questions.

Buying directly from a manufacturer may not be as desirable as buying from a microcomputer store. This is true because manufacturers are primarily concerned with selling their brands of hardware. On the positive side, however, manufacturers are well-equipped to sell and service their hardware. Some manufacturers have learned that programming is the most important aspect of micro systems, and they offer a range of application software for their machines. Moreover, many manufacturers offer substantial discounts to governmental organizations and can discount their products even further when organizations make large-scale purchases.

In the last five years, a new type of microcomputer system vendor has appeared on the market. These are **OEM's**, **VAD's**, or **turnkey** vendors. OEM stands for original equipment manufacturer and VAD for value added dealer. The terms are synonomous and imply that a vendor has added value (specific hardware elements, peripheral devices, operating systems, and application software) to make a more or less complete computer system for sale in a vertical market, such as local government. Turnkey vendors are organizations that package a complete system, sell and install it, provide user training and system support, and then turn it over to the local government for continuing operation. OEM's, VAD's, and turnkey vendors serving local governments are increasing with the use of micros in local governments.

Some of the advantages of buying from these vendors are that software and continued support are their primary concerns, and their software has been written for the governmental marketplace not for generic application to business and commercial organizations. These vendors typically stand behind the quality and functionality of their software through a warranty or a software support agreement that may be unavailable from other organizations.

All microcomputer equipment is sold with a warranty for a specific amount of time during which a malfunctioning piece of equipment can be returned for repair or replacement at no cost to the consumer. Until recently, 90 days was fairly standard for a hardware warranty but it is possible to get a one-year warranty on some brands of equipment. Some equipment is sold with better warranties than others, and the consumer should bear this in mind when purchasing hardware. The larger issue, of course, is what to do after the warranty expires. Should an organization purchase a maintenance contract or assume the risk associated with equipment failure?

While no advice is absolutely foolproof, most microcomputer equipment is highly reliable and relatively inexpensive. Hence, paying for a maintenance contract on hardware may not be cost-effective. Indeed, preliminary research suggests that most local governments do not buy maintenance policies for hardware. Instead, they have it repaired as needed. Several jurisdictions have found this to be an inexpensive yet effective maintenance method for stand-alone micros. ~~Micro hardware is highly reliable and~~ organizations that perform effective repairs at reasonable prices are becoming more widespread, especially in and around larger cities. Maintenance policies are recommeded for multi-user systems because of their increased complexity and because failure of a major component (for example, disk drive, system printer, or CPU) causes the system to be inoperable.

Several things can be done to improve the serviceability of equipment owned by local governments that choose not to buy maintenance policies or hardware. Putting the system through a good burn-in during the warranty period will often be sufficient to determine if any devices are defective. Disk drives should be cleaned regularly and equipment should be kept in relatively dust- and smoke-free environments. Careful backup procedures will ensure that subsequent failures will not cause the loss of data and files. Owners should arrange to rent or borrow replacement devices if a critical part of the system (for example, printer, disk drive, or CPU) is broken or has to be out for repair for a considerable period.

Typically, three alternatives can be used for hardware maintenance: **on-site** (that is, a repair person appears and performs equipment maintenance at the owner's location); transportation, known as **carry-in**, of the malfunctioning device by the owner to the vendor or service location; or **mailing or shipping** the device to a remote service location. These types of service are available from various organizations, including hardware manufacturers, national third-party maintenance firms, and local companies specializing in microcomputer support.

Each of these alternatives has pros and cons. For example, on-site service is the most expensive. But, an organization may have to wait only a few hours, depending on the terms of the maintenance policy, before a repair person arrives to correct the problem. Carry-in and mail-in maintenance service are less expensive, but they require that the user take the device to the service location or prepare and ship it to the maintenance organization. In both cases, the user must be prepared to operate without the equipment for days or even weeks while it is being repaired, unless other arrangements have been made.

Software support involves "handholding" by the vendor after the sale and initial training (if any training is provided). For many off-the-shelf and packaged programs vendors provide a telephone number (often toll free) that can be reached during normal business hours. Vendors answer questions and provide directions for program use. Remote diagnosis or correction of software bugs is not provided for off-the-shelf programs but may be provided for packaged software. Programs can often, although not always, be returned for replacement if they are found to be defective.

Another more extensive and expensive type of software support is provided by OEM's, VAD's, and turnkey vendors. These vendors frequently provide toll-free telephone numbers and continuing support, including on-site support, handholding, remote diagnosis, correction of bugs, provision of updated software releases, and modifications to installed software. Of course, these more extensive services are more costly. A rule of thumb today is that support for packaged software will cost from 10 to 15 percent of the purchase price per year.

A local government should decide what, if any, software support will be required and in its RFP ask vendors to respond with descriptions and costs for various levels of software support. As in the case of hardware maintenance, no hard and fast rule applies, but a local government should weigh carefully whether software support is really worth the price. This is particularly true in the case of off-the-shelf packages such as word processing, spreadsheet, and database management that are relatively inexpensive and quite reliable. Toll-free telephone support or support from the computer store where it was purchased is probably adequate for off-the-shelf software. However, for more detailed and complex packages, such as an integrated fund accounting system or a police records system, a local government will probably want to pay the extra cost to receive a higher level of support, at least for the first year or so of use.

A final word of advice on micro sales and support is that potential buyers should try to purchase their systems from reputable vendors. Avoid the snake oil salesman at all costs. A reputable vendor is one who knows microcomputer hardware and software and understands the needs of your organization, one who will be in business next year (and the next and the next), one who offers a variety of hardware and software, and one with whom a degree of rapport and trust can be developed.

**Where to Get Help**

Many local governments, especially small ones, may feel the need for expert assistance in undertaking a microcomputer procurement effort. Numerous sources of such assistance are available. In several states, university-based technical assistance organizations, applied research centers, public service institutes, and agricultural extension programs assist local governments that are purchasing data processing systems. Professional associations and organizations may also be sources of information about hardware, software, and other procurement issues and some may also provide technical assistance services. Organizations of this type include the International City Management Association, Public Technology, Inc., Government Finance Officers Association, and American Public Works Association. To be sure, this is not a complete list and, as time passes, more associations will probably become involved in providing support for their members.

Hundreds of independent consultants, management consulting firms, accounting firms, and data processing consultants are available to provide assistance with data processing and information management. Also, some communities have been able to use local citizens with expertise in data processing. Local governments that lack adequate staff expertise in data processing should look to one or more of these sources for assistance. The investment of a few thousand dollars in consulting assistance may save the organization tens of thousands of dollars and serious problems later. However, spending as much money on consulting assistance as the microcomputer system will cost is probably neither wise nor necessary. This may be easy to do, however, because consulting assistance can be expensive, compared with the relatively low cost of microcomputers. Consequently, balance must be sought between the need for help and its relative cost.

The selection standards applied to a prospective consultant or technical assistance expert should be the same as those applied to the purchase of any other service. Make sure the consultant is technically qualified, has experience in both data processing and local government, understands microcomputers, is independent of the sale of hardware or software, and can provide a list of clients that can be contacted for references. Be aware, too, that almost anyone can hang out a shingle and become a computer consultant. No certification, minimum competence, or licensing requirements exist. ~~are required.~~ This is another reason to exercise care in selecting your consultant, should you decide you need one.

Finally, never ask a vendor of computer hardware or software to provide consulting assistance unless the vendor will not be allowed to bid on the system. The same is true of accounting, auditing, engineering, planning, and other firms that sell computer software or hardware or are associated with vendors that do. The fox should not guard the chicken coop nor be given the key to the door.

# CHAPTER VII -- ISSUES OF IMPORTANCE

In this chapter, I discuss several issues of importance to local governments that own microcomputers or plan to purchase them. These issues include: hardware expandability and compatibility; software adaptability and transportability; documentation; training; computerphobia; user frustration and physical complaints; functional limitations; ~~rapidity of~~ change; and a policy on microcomputers.

## Hardware Expandability

All computers provide their users with potential benefits and confront them with distinct limitations. Micros are no exception. One major limitation to the use of microcomputers is CPU memory. For example, the maximum available memory for 8-bit micros is 128K. However, many older 8-bit systems are limited to 48K or 64K of memory. A local government using an 8-bit system will not be able to expand it beyond this maximum configuration, even if data files and application programs require a larger CPU capacity. Similarly, 8-bit micros have greater disk storage limitations. They are often limited to single or dual floppy disk drives, although hard disks are available for many models.

On the other hand, 16-bit systems have far more CPU capacity than 8-bit systems. For example, 16-bit systems can be purchased with as little as 64K of CPU memory. Most can be expanded to 640K of memory, and recent technological advances allow CPU expansion in the megabyte range. However, a 16-bit IBM or compatible micro, using the MS DOS operating system, can only address 640K of memory. Systems based on larger processors, like the Intel 80286 (and soon the 80386) and the Motorola 68000, can be expanded to several megabytes of memory. Today, the utility of micros with larger amounts of memory is limited by operating systems that cannot use that memory and by the lack of application software to run the larger machines.

Machines that can be used by local governments should be equipped with dual floppy disk drives, each capable of handling 360K diskettes, although micros with built-in 10 MB and 20 MB hard disk drives are becoming increasingly common. Both external hard disk drives and hard drives on expansion boards can be added to many floppy disk based machines. Of course, each expansion increment, whether CPU memory or disk storage, adds an increment of cost to the system. The larger and more powerful the system, the more expensive it is.

A local government should think of both initial and long-term requirements when deciding which type and model of hardware to acquire. A memory size of 256K on a stand-alone micro will probably be adequate initially, but if the organization's computing requirements are expected to grow, the system should be able to grow with them, at least to 512K if not to 640K. A system that is too limited may cause problems at a later date, and a system with greater expandability is a better buy.

**Hardware Compatibility**

Hardware compatibility is another important consideration, especially for those governments that plan to acquire more than one micro, that already have minicomputers or mainframes, or that want to communicate with other computers. In this regard, two types of compatibility should be considered. The first is strictly micro-to-micro compatibility. This can be achieved either by staying with identical or nearly identical hardware, such as all Apple IIe's, or all IBM PC's, or by buying computers with compatible operating systems, such as machines that support CP/M or MS DOS. In this way, the software that the organization purchases and the documents, spreadsheets, and databases it creates can be run on all of the hardware that it owns.

The second type of compatibility concerns communication with other computers, especially minicomputers, mainframes, and remote computerized networks and databases. Many micros on the market can be configured with additional hardware or software elements (for example, modems and communication software) to communicate with other computers, and micros with emulation capability can act as terminals on larger computers to upload and download files and data from them. Today, sharing programming with larger computers is not feasible generally.

A compatibility issue that arises because of IBM's lengthening shadow in the market is whether an organization should adopt the IBM PC as its microcomputer standard. Since the IBM PC was introduced, many observers believe that it has become a de facto microcomputer hardware standard and that whatever happens in the marketplace in the future, IBM will also set the standard. With few exceptions, other hardware manufacturers seem to agree, and in the past couple of years, these companies have rushed almost headlong to produce IBM-compatible machines or to enable their micros to run the MS DOS operating system.

What constitutes compatibility with the IBM PC? To begin with, we should identify the two principal IBM micros: the PC which uses the Intel 8088 microprocessor and the PC AT which uses the Intel 80286 microprocessor. Other IBM micros include the PCjr and the transportable, both of which IBM has abandoned; the 3270 PC; the PC XT370; and the recently released PC RT and the laptop PC. Not all of these machines are hardware or software compatible, so even within the IBM line, compatibility can be elusive.

To be compatible with the IBM PC or PC AT, a machine should run the same operating system as the IBM, MS DOS, which is the generic version of IBM's PC DOS. A machine which is said to be compatible with an IBM micro should be tested with software that runs on the IBM PC. Many experts believe that being able to run Lotus 1-2-3 unmodified is the appropriate test to determine whether a machine is compatible with the IBM PC. This is probably a good test for AT compatibility as well. A cautious buyer should also look for a machine that accepts IBM expansion boards and it should have enough vacant expansion slots for future additions. The machine should be based on the Intel 8088 chip for full PC compatibility, although some machines based on the 8086 chip claim IBM compatibility, and the 80286 for full AT compatibility. Smart buyers will test compatibility themselves.

The most important decision is whether an organization needs full IBM compatibility. Some organizations have answered affirmatively, others standardize on different machines, and still others have not standardized at all. To me, the key issue is not IBM compatibility, but standardization within an organization, regardless of the hardware and the operating system that becomes the standard. This way it is relatively simple to share software and data among machines, devices can be shared and used as backups in case of breakdowns, and hardware maintenance is easier. Although it can be argued that standardization on MS DOS (and, hence, IBM) will mean that a greater amount of application software is available for systems in an organization, the organization's specific needs should determine whether to standardize and should dictate the standard.

**Software Adaptability and Transportability**

As has been stressed repeatedly, **software is the single most important element of a microcomputer system.** Software should not only do the work for which it was intended, such as spreadsheet analysis, word processing, payroll or utility billing, but it should also be adaptable and transportable. **Adaptability** means that a software package can be used as written or can be modified for the specific purposes of the organization that purchases it. Elements such as screen formats, input and output formats, file and record layouts, printing formats, reporting requirements, and other aspects of the package must be flexible enough to be adapted to the organization's format.

**Transportability** relates, in part, to the earlier discussion of hardware limitations. Can the software be used on various micros within the organization? If the hardware or the operating systems are not compatible, the answer is no. If an organization anticipates purchasing several micros, transportability is an important issue. Transportability means that the organization will not be faced with unnecessary duplication of software purchases; one package can be shared by several users.

**Documentation**

One of the complaints most frequently voiced by computer users concerns something called **software documentation.** Documentation usually refers to the user's manuals or instruction guides that accompany microcomputer equipment and programming. These manuals are frequently incomplete, poorly written, difficult to follow, and frustrating to use. Sometimes they even contain incorrect information and instruction.

Toll-free hot-line telephone numbers will rarely substitute for good documentation. The user, therefore, should search for systems that not only perform required functions adequately but that also are supported by good user documentation.

For many off-the-shelf programs, supplementary texts are available. These are books produced by commercial publishers that explain the workings of particular packages, such as dBase III or Lotus 1-2-3; lead a user through practice exercises; and provide lessons in advanced program use. Books of this kind are often helpful no matter how good the user's manual.

Documentation can also refer to what is known as the **source code.** This refers to the actual programming language instructions that create the application software. Source code will not be available for most local government micro users because most of the software that is used today is the off-the-shelf variety and source code has not been released for them. Indeed, few vendors of packaged software will provide their customers with copies of source code. A local government might want source code for two reasons. First, if a local government contracts for custom-written programming, it should retain ownership of that programming and should keep the source code. Programming written by in-house staff should also include source code documentation to facilitate system support and future modification. Second, any time a local government is concerned about the viability or performance of a software vendor, it is reasonable to require that a copy of the source code be placed in escrow. In this way, if the vendor goes out of business or fails to fulfill contractual obligations, the purchaser has the source code and can contract with another organization to complete the installation or to provide software support.

**Training**

No one can use a microcomputer system without training, and while some persons learn more quickly than others, proficiency of use occurs only after some degree of training and considerable experience. The most consistent finding from case studies I conducted on the use of microcomputers in 1985-86, was that training was the most important factor in effective micro use in local governments. Cities which provided staff with training and allowed them time to practice on their micros were rewarded with greater benefits than cities in which little or no training was provided. Also, training and the availability of time to practice and learn were important factors in reducing user fear, resistance, and frustration.

Formal training is available at a cost from most microcomputer system vendors. A limited amount of training may be offered with the purchase of hardware or software. Actually, this training is not free; its cost has been built into the price of the hardware or software.

Another way to get training is from the instruction manuals, diskettes, and self-paced tutorials that accompany hardware and software, and from training software provided by third-party organizations. Training is available from local microcomputer stores, specialized microcomputer training organizations, colleges, universities, vocational-technical schools, and through seminars, workshops, and other programs offered by local and national training organizations and professional associations.

A greater price is paid, however, when formal training is not acquired and personnel are expected to learn to operate their micros without it. Personnel then have the burden of learning to use micros by trial and error, while continuing to do their regular work. Lack of training delays the time when the organization can expect to begin to see the benefits of system use. Also, serious mistakes, such as erasing data and files, can be made as the result of lack of training; moreover, the most efficient methods of system use may never be learned.

Local governments buying microcomputers should spend the necessary time and money on formal training for staff persons. Training should include operation of the hardware and instruction in each of the purchased software packages. A sufficient amount of training should be provided to ensure that local staff will be able to use each application program and all system capabilities effectively, and the training should be relevant to microcomputer uses in local government departments. Examples from sales and other business organizations will not be especially valuable to a personnel specialist, a wastewater treatment plant operator, or a police sergeant in a local government.

**Computerphobia and User Frustration**

In all of the cities that I have examined, at least a few persons have exhibited computerphobia. For whatever reasons, they are afraid of micros. In addition, whether initially afraid of micros or not, many persons become frustrated when using them.

Without attempting to list all of the possible sources of computerphobia and user frustration, local governments can take actions to mitigate their negative effects. First, training is essential. Second, users must be provided ample time to practice and to put their training to use in risk-free and nonthreatening environments. Third, a relaxed atmosphere that supports rather than forces microcomputer use will go far to reduce fear and frustration. Fourth, support for users, whether provided within the organization or through a third-party is also important because it provides learners and more advanced users with real, live, knowledgeable (and, hopefully, understanding) human beings to contact when they need help. Finally, attention to **ergonomics**--work station design and layout--will facilitate user comfort and convenience.

The popular media and even a few experts would have us believe that older persons, employees with lower socioeconomic status, and personnel at the lower end of the organizational hierarchy experience computerphobia and actually resist learning about micros more than others. I know of no systematic data that demonstrate this argument. Moreover, evidence from my case studies shows that persons of all ages, socioeconomic status, and position in the hierarchy both embrace computers and fear them, welcome and resist them, are frustrated when learning to use them and are frustrated because they do not have access to them. The case studies also show that while attention to the considerations listed above will not eliminate computerphobia and user frustration totally, it can mitigate them considerably.

**Physical Complaints**

The popular media routinely carry articles about physical complaints that are said to be associated with microcomputer use. Evidence supports some of these complaints. For others, the evidence is contrary. And, for others still, the jury is out.

One complaint for which evidence is contrary concerns radiation emitted by computer monitors and its alleged association with pregnancy disorders, cataracts, and other ailments. Scientific studies have not demonstrated that either excessive radiation levels exist or that such disorders are caused by VDT use. Studies are still being conducted and their results should be monitored carefully. Although some organizations have made a strong emotional appeal regarding both issues, the available evidence does not seem to warrant concern.

Eye strain, back aches, and other musculoskeletal complaints associated with computer use appear to have more substance. Often these problems are reported when personnel sit at VDT's and work stations for eight hours per day. As anyone who has worked at a typewriter for several hours at a stretch will attest, backaches and muscle cramps do occur. Further, using VDT's can be a challenging experience for persons who have been blessed with bifocals.

Here again, attention to ergonomics is important. Proper lighting, glare filters for video monitors, furniture especially designed for computers, chairs with back support that encourage correct posture, proper keyboard height, and adjustable monitors make the use of microcomputers easier, more convenient, and more comfortable. They also reduce physical stress. Good ergonomics is humane and, for that reason alone, should be pursued. It also makes good business sense because it increases user productivity. Employers should also focus on the way in which tasks are performed to reduce or eliminate electronic exploitation of workers.

### Functional Limitations

To hear some vendors tell it, microcomputers have virtually no limitations and can be used for virtually all purposes known to man. This is nonsense. Here are some of the more important functional limitations that potential purchasers should know.

**Memory and Disk Storage.** Currently, 640K is the maximum usable amount of memory for commercially available 16-bit micros, and 40MB of hard disk is about the maximum effective disk storage capacity. Of course, many micros have far more limited maximum configurations. These capacities, as great as they are, cannot compare with the megabytes of memory and gigabytes (billions of bytes) of disk storage offered on minicomputers and mainframes.

Micros based on 32-bit chips are expected to enter the market relatively soon. Some observers expect them to sound the death knell for minicomputers because 32-bit micros will be every bit as powerful for a fraction of the price. For example, the Intel 80286 chip has the capability to address 16 MB of memory and the 80386 chip will address 4 gigabytes (or billion bytes) of memory. In the near future, then, microcomputer memory and disk limitations will be a thing of the past. For now, however, micros simply cannot do the work of minicomputers and mainframes. This is especially true for local governments because of the lack of software to run on the larger micros.

**Single User.** Memory size, bit architecture, operating systems, and application programming limit most micros today to single-user systems, and even larger micros are being used primarily for single-user applications in local governments. True multi-user, multi-tasking micros have entered the market only recently, and many months or years will be required for software development to catch up with the hardware capabilities of these systems.

**Speed.** The 8- and 16-bit micros are relatively slow. Waiting for one of these devices to retrieve a piece of information from a large database or to print a lengthy report can be frustrating, especially when a mainframe or a minicomputer can accomplish the same task in a fraction of the time. Of course, 8- and 16-bit micros are considerably less expensive than larger systems, and, unless speed is essential, a slower system can be justified easily on the basis of lower cost. Furthermore, even with relatively slow speed, micros are far ahead of the speed of data processing with manual systems. The newer 32-bit systems, which will be on the market soon, will be several times faster than earlier micros, and, although somewhat more expensive, they will be far less costly than minicomputers, while having similar processing capabilities and speed.

**Perceptions of Micros.** Microcomputers may be perceived as toys in an organization. If this happens, personnel may not take the micros seriously, thus, the computers will not be used. The same can happen, of course, as the result of fear of microcomputers. People will not use them if they are afraid of them.

Another potential problem is that almost every organization has a closet programmer or two. As soon as a micro appears, these otherwise mild-mannered souls burst out of the closet intent on writing programs. They can be a valuable asset if their enthusiasm is channeled properly, but the introduction of a microcomputer can also result in the loss of effectiveness and efficiency of these personnel. The closet programmers will spend their time playing with the micro rather than doing useful work.

**Lack of Standardization.** Lack of standardization is a scourge on the microcomputer industry. It means that local governments must be knowledgeable about purchasing micros to acquire systems that will work effectively. Although lack of compatibility is the rule throughout the world of computers, the problem is magnified somewhat in relation to micros because they seem so easy to use and are so inexpensive. No surprise is greater, and possibly more costly, than the discovery that the newly purchased micro will not run certain desired programs, that it is incompatible with other systems the organization already owns, or that additional hardware or software elements must be purchased before it will work properly.

**Competition.** Competition or conflict within an organization can affect the use of a micro. This may mean competition among staff persons for use of the systems. Whose is it? What are the functions to which it is dedicated? Which persons and functions have priority?

Where user competition occurs, users may become frustrated and abandon use of the micro. One effective way to avoid this problem is to schedule use and set priorities. My research has shown that multiple users can, in fact, share machines effectively, but it also has shown that the pressure of multiple users on a single machine often results in the acquisition of additional machines.

A second form of competition can occur between the micro and the data processing department in local governments that have larger computer systems. Traditional data processing system managers and personnel may fear the intrusion of micros and the competition from them and, therefore, may oppose the introduction and use of micros in the organization. These persons may also refuse to provide adequate support for micros. In almost every city I have studied, pressure for acquiring micros has come, in part, from persons at the departmental level who have been denied effective access to the programming and power of the mainframe or minicomputer.

**Duplication.** In organizations that have other computers, miros, if not acquired carefully, can also lead to unnecessary duplication of effort. Micros will be used to do or redo much of what is done or should be done on the minicomputer or mainframe. Multiple points of entry of identical data will develop. Databases will be duplicated on micros around the organization, often with little attention to which one, if any, is up-to-date and accurate.

**No Panacea.** As pointed out in Chapter II, a microcomputer is not a panacea for bad management practices. Thinking that the introduction of a micro into an organization will cure bad management practices would be foolhardy. It can, however, help good managers to be better by making their work easier, faster, more accurate, and more comprehensive. However, local governments should never automate systems or practices that are inefficient, ineffective, or error prone. To do so will mean that the same mistakes will be made faster and retained longer.

**Technological Change**

During the writing of this book, many new hardware and software products for microcomputers were released, and many more are expected to be introduced in the near future. In this same period, several hardware and software manufacturers went bankrupt, and others chalked up huge financial losses. Even the reigning industry giant, IBM, was forced to abandon certain of its products, notably the PCjr and the transportable PC.

The rapidity of technological change and the volatility of the microcomputer market have given pause to more than one potential purchaser. Many persons are legitimately concerned about whether a system bought today will be substantially less expensive or even outdated in a few months or years? (The answer is yes to both questions.) They may also be concerned whether the model acquired will even be on the market and whether the manufacturer will still be in business in a few months or years.

**System usability is the key** to the issue. Local governments ordinarily do not buy computers to stay on the leading edge of technological change. Instead, they buy them to accomplish specific functions and to do the work of the organization. Hence, an 8-bit micro with 64K of memory and a dual floppy disk drive used for word processing or spreadsheet analysis will be as effective in performing the work for which it was purchased when it is five years old as when it was brand new. The same can be said for a 512K 16-bit machine. In five years, it will do everything that it is able to do today.

If an organization waits to buy a system until the newest and the best model comes on the market, it will wait forever because new and better products, at relatively lower prices, are being introduced constantly. Waiting also means being unable to take advantage of the benefits of a microcomputer in the interim.

To guard against the risk that a manufacturer will go out of business, leaving the local government with essentially useless equipment, the following considerations may be helpful: buy a system that (1) is based on one of the more widely used memory chips, (2) relies on one of the more widely used operating systems, (3) has ample third-party software, and (4) has adequate hardware support. A micro purchased with these considerations in mind will remain functionally effective for a long time. Technological change and marketplace volatility can be frightening, but the use of commmon sense and the guidelines presented in this book can help to minimize their negative effects.

**Policies on Micros**

Local governments may find useful the adoption of formal policies regarding microcomputers. Currently, microcomputer policies in local governments are the exception rather than the rule.

Such policies may be as simple as limiting the amount of funds that can be spent for a given piece of equipment or as comprehensive as specifying the type of hardware, operating system, and application software that can be purchased and requiring review and approval of a purchase by a higher authority. Policies on microcomputers may also limit the circumstances under which micros can be used and place their use in the broader context of information management within the organization. In some cities, for example, applications can go on micros only if they are stand-alone, department specific, and involve unique databases. All other applications must go on the mainframe or minicomputer. The only exceptions allowed are in cases where the cost or length of time to place such an application on the larger system would be excessive.

Regardless of the detail of the policy, an organization that plans to acquire micros needs to ensure some degree of hardware and software compatibility, prevent conflict over system use, prevent unnecessary duplication of hardware and software, and maximize the effective use of this technology. In the absence of a formal policy, more limited procurement guidelines that address the issues raised above regarding hardware and software can be beneficial.

# CHAPTER VIII -- MICROCOMPUTER IMPACTS

Public organizations implement microcomputer technology to accomplish some end or purpose. Both general and specific reasons motivate the acquisition of microcomputers. General reasons tend to be global in nature and display an underlying **faith in technology.** This faith may be unjustified because, as many studies of technology adoption have shown, the **management of technology** is more important than the technology itself. Faith in the technology is also unjustified because of the absence of research findings on the impacts of microcomputers. Currently, little research has been conducted, and, hence, little systematic knowledge is available about the impacts of microcomputers.

General reasons for acquiring microcomputers focus on potential uses and positive impacts. I have chosen the designation general reasons because they do not identify specific uses or tasks. In several of the cities I studied as part of a broader project on microcomputers and local government,[25] procurement personnel said that micros were acquired "to see what would happen" and because they were certain that micros would be put to good use. The assumption here was that beneficial results would occur. In other cities, micros were acquired "because it is the thing to do" and "in order to keep up with the technology." Some persons and departments bought micros simply because other units within city government had them.

Other general reasons for buying micros included:

- o Obtaining experience with micros,
- o Improving accuracy,
- o Saving time,

- o Improving productivity,
- o Doing more work,
- o Doing work that could not be done before,
- o Making work easier,
- o Improving efficiency, and
- o Improving the appearance of documents.

Specific reasons for acquiring microcomputers were related to particular activities. To put it another way, they were **task-oriented.** That usually meant that someone in the organization had determined the jobs to which the micro could or should be applied. More often than not, these jobs were related to the activities of a particular department. This was true regardless of the software that was used, whether it was off-the-shelf or packaged. The following is a partial list of the specific reasons for which micros were acquired in the eight cities I studied.

- o Budget preparation,
- o Annexation studies,
- o Plant maintenance management,
- o Fleet management,
- o Library administration,
- o Public access,
- o Contractor's examinations and licenses,
- o Audit schedules,
- o Engineering estimates,
- o Engineering calculations,
- o Statistical analysis,
- o Crime analysis,

- o Financial monitoring,
- o Financial reporting,
- o Financial analysis,
- o Fingerprint identification,
- o Document preparation,
- o Accounting,
- o Traffic signal optimization,
- o Public housing management,
- o Sewer flow analysis,
- o Productivity reporting,
- o Street lighting analysis,
- o Project management, and
- o Automation of police records.

At least in these cities, specific reasons for acquiring microcomputers far outnumbered general ones. Yet, it was clear that underlying almost all of the reasons was faith in the technology and belief that positive outcomes would occur. This was true regardless of the extent to which a city had engaged in a rational planning process for acquiring micros (as recommended in Chapter VI).

**Who Uses Micros?**

Microcomputers in public organizations are seen by users and managers alike as **instrumental objects.**[26] That is, as tools with which to do work. This is evident from the reasons they gave for buying micros. It is also evident from examination of the ways in which cities used micros and users talked about them.

Because micros are viewed as instrumental objects and are used to perform specific tasks, users vary according to the tasks being performed. In local governments, micros could be used by five categories of personnel: elected officials, managers, professional-technical staff, secretarial-clerical employees, and blue collar workers. In the cities studied, managers, professional-technical staff, and secretarial-clerical employees were the principal microcomputer users, although patterns of use were not consistent within and across organizations. Top managers in some cities used micros extensively. In other cities, they did not touch them, although they may have used information produced on micros. Mid-level managers were more likely to use micros but this was often because they retained professional or technical responsibilities. Managers in smaller places were more likely to use micros than managers in larger ones, possibly because they had fewer people working for them.

In all of the cities studied, professional-technical and secretarial-clerical employees used micros. This was because of the micro's utility in performing tasks that these personnel normally performed using other methods. Examples for professional-technical employees included budget preparation, financial analysis, annexation studies, and fingerprint identification. Examples for secretarial-clerical employees fell principally in the area of word processing, for example, preparing correspondence, memos, and documents, but also included financial monitoring, report preparation, and data entry.

In these cities, elected officials and blue collar workers did not use micros. This was probably because of elected officials' traditional reliance on staff to provide information rather than on themselves to produce it. The micro invasion thusfar has been limited to the office, therefore, blue collar workers are not using them. One exception to this finding is that in some local governments, utility meters are read by employees who use hand-held devices driven by microprocessor chips that physically interface with microcomputers to upload and download customer usage data.

**Extent of Use**

The amount of time a person spends using a microcomputer is not necessarily related to the effectiveness of use. This is because some tasks require considerable amounts of human-machine interaction and others do not. Yet, regardless of the extent of human-machine interaction most uses produce positive results. For example, data entry for accounting or for police recordkeeping purposes may require significant amounts of human effort at the keyboard. Interestingly, very little machine power is used in data entry. Other uses, such as engineering calculations, preparation of roadway design alternatives, "what if" analyses, budget development, and preparation of monthly reports require relatively little human-machine interface after data are input initially. These types of activities require greater amounts of processing time.

Thus, where it might take a typist all week to prepare a lengthy report using a word processor, an engineer can complete several design alternatives for a street segment in a few hours. Both uses are effective in their end results. They save time, produce more professional looking documents, provide more and better information, and simplify task performance. But, these effects are unrelated to the amount of time that a person physically uses the machine. Hence, measuring the effectiveness of microcomputer use by the amount of time users spend in front of the machine is inappropriate. The quality and quantity of the product is what counts.

One area where the amount of use time is relevant is learning. Users must spend a significant amount of time using microcomputers to become proficient, regardless of whether formal training is provided. This requires a commitment on the part of the organization to provide users the time they need to learn to use the micros, apart from their daily job responsibilities. It also requires a commitment on the part of the users to study software and hardware manuals and to use the systems. Proficiency develops only through use and this takes time.

The extent of use varies with the type and amount of work and also with the calendar. For example, while the flow of word processing activity may be somewhat constant, report preparation is often a monthly, quarterly, or annual event. Accounting and financial monitoring activities may also be relatively constant, but budget preparation is seasonal, requiring considerable time and effort in the months preceding submittal of the budget to elected officials. Use may also be related to project and funding cycles. Use variations of this nature are consistent with the concept of a microcomputer as an instrumental object, a tool with which to do work. When there is work to do, micros are used.

**Impacts**

Until recently, few if any well designed research studies had been conducted on the impacts of microcomputers.[27] Much of the information on impacts is contained in marketing literature. Marketing literature must be considered suspect because its purpose is not to inform but to sell. The popular media have also provided numerous accounts of micro use. These stories have tended to rely on superficial examples, anecdotes, user testimonials, and expert opinion. Persons and organizations with an ax to grind, who have inveighed against what they believe to be the inhumane consequences of microcomputer use, have been another source of information about microcomputer impacts.

Marketing literature and reports in the popular media are almost always uncritically supportive of microcomputers. Conversely, groups focusing on the negative aspects of micros have all too much in common with the anti-technology Luddites of early 19th century England. The problem for the governmental manager is that information from these sources is rarely based on solid research findings. Nevertheless, adoption of micros has proceeded apace, and it is time for researchers to catch up with the adoption and use of this new technology.

Within the past two or three years, a few researchers have begun studies of the uses and effects of microcomputer technology. Preliminary findings from some of this work are beginning to find their way into publication. Fortuitously for organizations that adopted microcomputers, these findings suggest that the preponderance of microcomputer impacts are positive--on work, organizations, and people. Although negative effects occur, they are few in number, limited in severity, and largely controllable through intelligent management.

**Impacts on work.** Positive impacts on work have been predicted (or, perhaps, hoped for) in the areas of cost savings and cost avoidance; accuracy; efficiency and productivity; time savings; and ability to do work that was not possible previously. Anticipated negative effects have been that during the introduction of micros work activities would be disrupted, and that over the long term they would impose more work on employees. These predictions were extremely accurate, even though the basis for making them was weak.

First, the bad news and there is very little of it. Micros do not often produce cost savings or cost avoidance; less still are they used to generate revenue. Certainly, examples of positive effects in all three categories can be found and some have big numbers attached to them. Seward, Nebraska, paid $20,000 for a micro for electric utility load monitoring and saved over $100,000 in the first two years the system was in operation. Finance department employees in Omaha, Nebraska, used a spreadsheet on a micro to analyze the city's outstanding bonds and found that by refinancing 128 issues the city could save nearly $3 million. These and other examples, however, while significant to particular jurisdictions, are few in number.

Micros do disrupt work, during their introduction and for a few months thereafter. This seems to be true no matter how good the implementation plan. Such a finding should not be surprising. After all, a new unfamiliar technology is being installed and personnel have to learn how and when to use it, while continuing to perform their regular jobs. Disruption can last longer if personnel are not trained adequately, provided a positive learning environment, afforded time to learn, given the proper hardware and software tools, and if micros are applied to inappropriate activities.

Many of the personnel that I interviewed in the case studies said that their work loads increased once they began using micros. This meant a couple of different things. The amount of work they accomplished increased--number of pages typed, number of budget alternatives prepared, and other quantifiable outputs. Many also said that once it became known that they could use a micro, other persons asked them for instruction, to solve problems, or to do work for them. In only a few instances did personnel feel that this imposed a burden on them. For the most part, they simply observed that the machines enabled them to accomplish more work. What is more, they viewed this aspect of micro use positively.

Now for the good news, most of the reported and observed effects of microcomputers on work were positive. In all cases, the processing power and speed of the equipment, user-friendly software, and commitment by employees to learn and use the systems made these effects possible. Efficiency, productivity, accuracy, timeliness, quality and quantity of information, and quality of documents improved. The two most significant positive effects on work were time savings and the ability to do work that was not feasible previously.

The following examples of time savings were reported by the jurisdictions studied.

- o Budget alternatives were prepared almost instantly during budget sessions, rather than taking several days;
- o Lengthy monthly reports were prepared in half a day, rather than in two and one-half days;
- o Union contracts were revised in minutes, rather than in hours; and
- o Engineering design alternatives were prepared in 10-15 minutes, rather than in 4 hours manually;

The time that was saved accrued to the benefit of the organization. It was used to catch up on backlogs of work, to perform additional work, and, when combined with the processing capabilities provided by the microcomputer, to perform work that was not possible previously.

Indeed, micros were used extensively in all jurisdictions to do work that could not or would not have been done manually. Often, this involved sorting through large databases and conducting detailed analyses of data. The following are some examples:

- o In-depth annexation studies,
- o Analysis of fuel utilization patterns for city vehicles,
- o Examination of urban land development alternatives,
- o Traffic signal optimization studies,
- o Street lighting analyses,
- o Analysis of outstanding bonded indebtedness,
- o Examination of potential impacts of urban development programs,
- o Detailed project scheduling, and
- o Ability to make changes in textual and numerical documents.

**Impacts on the Organization.** Several effects of microcomputer technology on organizations have been predicted. These include decentralization of computing power, improved organizational effectiveness, improved decisionmaking, flattening of the organizational hierarchy, blurring of the distinction between professional and clerical personnel, increased supervision, and changing power relationships. Research suggests that some of these effects are true, some are not, and that the overall effect of micros on organizations is positive.

Computing power, the use of micros as sophisticated calculators or number crunchers, as analytical engines, as information management tools, and for more mundane tasks, such as word processing, was decentralized with the introduction of microcomputers in the organizations I examined. In local governments with mainframes or minicomputers, staff with micros no longer were dependent on the data processing department for all of their computing needs. They had their own computers to employ as they saw fit. One reason many cities acquired micros was because some personnel did not have access to the mainframe or minicomputer. The opposite side of this coin is that, in some organizations, the central data processing department opposed or tried to control the diffusion of micros.

Organizational effectiveness is difficult to measure. If defined narrowly to the delivery of measurable services, either to an external client or to persons or units within a city of county government, micros have positive effects. The public works director in Olathe, Kansas, was able to manage his commercial sanitation operation more effectively with a micro. This increased the level of customer service and produced more revenue from refuse collection.

Fiscal analysts and land-use planners in Bellevue and Omaha, Nebraska, used micros to examine proposed annexations. They produced more detailed analyses and better information about costs and revenues associated with annexing certain areas. This information is used by managers and, ultimately, elected officials when deciding whether to annex. The Urban Development Block Grant (UDBG) manager in Pasadena, California, used a micro to examine whether a UDBG funded program would produce harmful impacts in sensitive areas of the city. The analytical capabilities of the micro indicated that the program would have positive, rather than negative results and it was implemented. Public assistance workers in local offices of the Michigan Department of Social Services are better able to serve their clients because of the use of micros.[28] The list could go on indefinitely and, in each case, would show how micros were used to improve the delivery of services either externally or internally.

Microcomputers, however, do not improve the quality of decisionmaking. This is because, simply put, computers--micro or otherwise--do not make decisions. They can process words, crunch numbers, manipulate data, and, hopefully, produce more and better information than possible with manual methods. But, only human beings can make decisions.

Properly utilized, information produced on micros can influence decision-making. The personnel director of Marshalltown, Iowa, used a spreadsheet program to estimate the costs of union bargaining demands during contract negotiations. These data were then used to develop the city's responses, and also to demonstrate to union negotiators the economic basis for those responses. The city's decisions in contract negotiations were influenced by data produced on a micro. According to the personnel director, one consequence was lower costs to the city.

According to many local government personnel, "hard data" produced on micros are unarguable. After all, they come from a computer. One can be seduced too easily into believing something just because it was spewed out of a computer, and I recommend a healthy amount of skepticism about these devices and their printouts. Nevertheless, accurate, systematically collected data can be used to validate previous decisions or to change them when necessary. The street superintendent in Englewood, Colorado, knew that his drivers were not complying with the city's policy to use compressed natural gas (CNG) in their vehicles. However, data from the city's fuel management computers were not reported adequately so he was unable to prove his case. He wrote a program for his home computer to reformat the data to show fuel use by driver and vehicle. Within a month, CNG use by all employees in his division rose from around 50 percent to over 90 percent. He had shown them unarguable data which also supported what he knew previously at a more visceral level.

Some observers have suggested that the introduction of microcomputers will cause a flattening of the organizational hierarchy. This means that the decentralization of computing power, especially machines that are connected to electronic networks to send and receive messages, will enable fewer managers to supervise a greater number of employees. According to these observers, micros will also blur the distinction between professional and clerical employees by enabling the latter to perform tasks with micros heretofore requiring the skills of the former.

Evidence from the case studies does not support these predictions. Perhaps, this is because most micros in these cities were stand-alone devices that were not connected to electronic networks. In addition, the micros were used as **personal tools** by employees to assist them in the performance of their work. A limited amount of evidence suggests that lesser skilled employees, for example, technicians and clericals, used micros to do work that was performed previously by employees with greater skills. This evidence does not suggest either a flattening of the hierarchy or a blurring of skill-related distinctions among categories of employees. Instead it indicates that micros enable employees to do types of work that they might not have been able to do before.

As more micros are introduced and interconnected electronically, these predicted changes could occur, and they bear watching. In my opinion, however, fundamental changes in the organization of local governments and in managerial and supervisory practices must occur before these effects will appear. Then, the question will be which cause, technology or organizational change, produced the effect? If the answer is the latter, were the changes related or unrelated to the technology?

Researchers who have examined the effects of mainframe computer technology have found that changes in levels of supervision and in individual power relationships occur with mainframe computing. They have also found that computer technology tends to reinforce existing organizational structures.[29] ~~and power relationships.[29]~~

Case studies on the effects of micros found that neither extent of supervision nor individual power relationships were affected by micros. Supervision was not affected because of the way micros were used in these cities--as personal tools to accomplish work. A different utilization pattern, for example, strict data entry with close productivity monitoring, might have produced different results.

The introduction of micros seems to affect internal organizational relationships in at least one way. Instead of supporting the status quo, micros decentralize computing power and distribute it to users. This means that users are no longer dependent on the organization's data processing department. Where centralized control is exercised by the data processing department over the micros--as was the case in Michigan's Department of Social Service--decentralizing effects did not occur.[30] This is a far cry from saying that micros support the status quo. In any event, these findings support the notion that the management of the technology, not the technology itself, is the crucial variable in determining technology impacts.

One additional way in which power relationships may change concerns individual users. In most of the cities studied, one or a few personnel gained enhanced reputations because of their facility with micros. They became the local computer gurus. Some, but not all of these gurus, were called upon for advice, problem solving, and other types of support by other users and by management. This status, however, did not seem to enhance or otherwise change their power in the organization relative to others. Indeed, some of them were looked upon by other personnel in their cities as, well, just a little bit strange.

Local governments benefited from the use of microcomputers in several ways: improved productivity, ability of personnel to do more work and to perform work that was not possible previously, improved effectiveness, and improved information. Although some internal organizational changes occurred, especially the decentralization of computing power, predicted negative effects at the organizational level did not occured.

**Impacts on People.** In discussions of the impacts of micros on people, two extremes exist. On the one hand are those who claim that computers are bad for almost everything, including physical and emotional health. On the other hand are the technophiles who have adopted an equally myopic view that there can be nothing better, more edifying, and more satisfying than a computer on every desk. Both sides are wrong, although for different reasons.

The effects of microcomputers on people fall into three broad categories: physical, emotional, and functional. I will examine each in turn.

Some extreme comments would have us believe that computer monitors or video display terminals (VDTs) on computers cause eyestrain, cataracts, birth defects, and even sterility. Researchers have found a link only to the problem of eyestrain, and it is associated more with glare and lighting, which are correctable, than with VDT use. However, because the other alleged problems are potentially serious, research on them and any possible link to VDT use continues and should be monitored closely by concerned managers.

Physical problems that are associated with computer use include musculoskeletal complaints, such as backache, neckache, and muscle cramps. These have been found to be bona fide complaints in some circumstances, and can be addressed by attention to ergonomics and redefinition of tasks. This means proper furniture, correct lighting, reduction of glare, attention to length of time at the VDT, and other environmental and work performance considerations. The only instances of musculoskeletal complaints reported in the case studies occurred where users sat at poorly configured work stations for hours at a time entering data.

The emotional impacts of microcomputers include user frustration, computerphobia, and user satisfaction. As noted in Chapter VII, user frustration and computerphobia were found, in small and declining amounts, in all of the cities studied. To a certain extent, these should have been anticipated. They probably are unavoidable consequences of introducing a new technology. Management can take actions to minimize and even eliminate them, and experience using micros also helps to overcome them.

In Chapter VII, I noted that in all of the cities studied (and this finding is repeated in other studies), levels of user satisfaction with micros were high. This was true even where users had suffered considerable fear and frustration during the initial stages of microcomputer implementation. Common statements from users were, "I don't know what I'd do without my micro," "I don't know what I'd do if they took it away," and "They'd have to fight me to take it away."

Potential impacts occur in at least four areas at the ~~functional~~ VOCATIONAL or work level: the nature of the job itself, the skills required to perform the job, the amount of work accomplished, and employee perceptions about the job. In the cities studied, the nature of employees' jobs did not change with the introduction of micros. What changed was the way in which tasks were performed, the speed and accuracy of performance, and the tools used to perform tasks. The job of an accountant, police officer, planner, wastewater technician, design engineer, or clerk-typist was not redefined. However, the skills needed for the job changed--the ability to use a microcomputer and related software was added. When I asked users about it, most felt that on balance learning new skills was positive, even though it may be frustrating initially. This was because of the capabilities provided by the micros to do more work and to do it better.

The amount of work performed increased for almost all users. So too, in the view of users and managers, did the quality of work. Throughout the cities studied, employees felt that using a micro enlarged and enhanced their jobs. As more than one respondent put it, "I now have the tools to do the professional job I have known all along we should do in this department."

A limited amount of physical complaints, user frustration, and computerphobia seem to go with the microcomputer territory. Most of the effects on people, however, are positive and include high levels of user satisfaction, a sense of job enrichment and enlargement, a feeling of professionalism, and the ability to do more and better work. Moreover, negative effects can be addressed and, in many cases, diminished or eliminated through sensible, intelligent management actions.

**Conclusion**

The simplest and most direct way to summarize the effects of microcomputers in local governments is to say that much of the marketing hype was right. (Not that the writers of the marketing hype knew what they were talking about, but it was right nevertheless.)

Can anything really be this good? At this point the skeptical reader may wonder whether it was not the researchers or the methodologies that failed to uncover expected negative effects or overemphasized the positive ones. I was concerned about the same thing. Consequently, in my case studies I probed for both types of effects. To determine potential negative effects, I asked questions about disruptions of work; interpersonal communications and personal relationships; increased costs, user frustration, and computerphobia; declining morale; reductions in the number of personnel; increased supervision; changes in hierarchical or power relationships; decreases in quantity or quality of work; physical complaints; and more. The results were clear and unequivocal. Most of the effects of microcomputers in these cities were positive, many significantly so, on work, organizations, and people. Some negative effects were reported, but they were few in number, limited in severity, and most could be corrected.

In addition to conducting case studies, I also helped to conduct a massive literature review during the past year to identify other studies concerning the effects of microcomputers. The research-based literature on the effects of computers in general and micros in particular is small. But, it tends to support the findings of my case studies.

None of this should suggest, however, that micro use is without a price and some pitfalls. And some negative effects are probably inevitable, even under the best of circumstances. On the whole, however, microcomputers appear to be sound investments for local governments.

Can anything be done to improve the use of microcomputers, to enhance their positive effects, and to reduce their negative effects? Of course. To begin with, micros in city governments are used as personal tools for specific, if sometimes limited functions. But, their acquisition and use are largely unplanned and unmanaged. One finding from studies of large computer systems that appears to have applicability here is that good management improves the positive effects of large computer systems.[31] Cities should be more attentive to planning for and managing micros, to improve their use, and to maximize their positive effects.

Local governments--and this applies to other organizations as well--should provide user training and user support, address issues such as how do micros fit into information management (not just computation and calculation) for the broader organization, and ensure ongoing evaluation of micro use and effectiveness. Potential users should not be coerced but lead into micro use, and all users should be provided ample time to learn the devices (and related software) away from the pressure of daily work. Attention should be paid to ergonomics and task performance to prevent the physical complaints associated with the use of micros.

The case studies provided other lessons that may be of value to organizations that already have or are considering buying microcomputers. Among others, the following are particularly noteworthy:

o Hardware was not an especially critical factor for the effective use of microcomputers. Hardware from most manufacturers worked effectively and reliably.

o Software was important because without it the micro would not work. But, particular brand of software did not seem especially important. The cities studied owned and satisfactorily used a range of hardware and software products.

o Nearly all systems were stand-alone units, and many of these were shared by more than one user. Few were used for communication and none were configured in local area networks. Two cities had made commitments to office automation and had substantial micro-to-mainframe communication capabilities. Only one multi-user micro was reported.

o Micros were viewed almost exclusively as tools with which to do work, and they are used in almost every conceivable area of local government. Uses were widespread and varied, and they were task and department specific.

- o Micros were acquired for global reasons and with specific tasks in mind.
- o Micros were used for the purposes for which they were acquired, but uses rapidly expanded beyond initial activities.
- o Use of machines was relatively high but varied with type of work, fluctuations in demand from related activities, and time-driven considerations.
- o With the exception of elected officials, all categories of personnel and personnel in an array of jobs and ranks in the hierarchy used micros.
- o User satisfaction was high, although users paid a price to achieve satisfaction. That price was expressed in terms of the time invested to learn the system and in initial user frustration.
- o Once micros began appearing in most of these organizations, more followed. Diffusion was for the most part rapid and widespread.

During the past few years we have witnessed a dramatic diffusion of microcomputer technology. This study is certainly not the final word on the impact of microcomputers in public organizations. My findings, however, should help to quiet some of the concerns that microcomputer technology will not live up to its advance billing, or, worse, that the negative effects will outweigh the positive ones. These findings should be used by local governmental personnel to examine the uses and effects of microcomputers in their organizations. Finally, they should help to refocus management concerns from the uses and effects of micros to the ways in which positive effects can be maximized and negative ones minimized.

# FOOTNOTES

[1]The Altair was probably the first microcomputer to appear on the American market. It was sold as a kit to be assembled by the user, and its appeal was limited largely to hobbists. Radio Shack's TRS 80 was on the market earlier than the Apple, but the contemporary litany credits Jobs and Wozniak with opening the micro market with their innovative product.

[2]See Gary B. Shelly and Thomas J. Cashman, Introduction to Computers and Data Processing, (Fullerton, CA: Anaheim Publishing Co., 1980), chapter 2, for the number of minicomputers and mainframes. According to Aaron Goldberg, research manager, International Data Corporation (IDC) an estimated 10 million micros were sold by 1984. In the years since, at least another 10 million have been delivered and estimates of future sales continue to be high.

[3]Infoworld, March 3 and 10, 1986. See related article in ComputerWorld, May 27, 1985, quoting the U.S. General Services Administration that acquisition of microcomputers by federal agencies in FY-85 increased 400 percent over FY-84, from 8,000 to 37,000 units.

[4]Donald F. Norris and Vincent J. Webb, Microcomputers: Baseline Data Report (Washington, DC: International City Management Association, July 1983), pp. 1-2.

[5]Data from 1985 were made available by the International City Management Association and will be reported in an article in The Municipal Yearbook 1986 by John Scoggins who conducted the survey.

[6]Craig Brod, Technostress: The Human Cost of the Computer Revolution (Reading, MA: Addison-Wesley Publishing Company, 1984), p. 102. This is fairly typical of this author's view of the effects of computers.

[7]Robert W. Pearson, "Computers and Contemporary Society," 1983-84 Annual Report of the Social Science Research Council.

[8]With appreciation for the humor of Bob Newhart.

[9]"Data and Information Processing in Business," DataPro Reports on Minicomputers (Delran, NJ: DataPro Corporation, 1980), p. SC10-300-102.

[10]This discussion of the evolution of computer technology is based in part on Shelly and Cashman, chapter 2. It appears, however, to be incorrect in one respect. As in many other contemporary works, ENIAC is credited with being the world's first electronic computer. Recent litigation has established that Dr. John Vincent Atanasoff of Iowa State University developed the world's first electronic computer in 1939, seven years prior to ENIAC.

[11]For the concept behind this figure, I am indebted to John Scoggins, consultant and author of Computers and Local Government Workshop (Athens, GA: Institute of Government, University of Georgia, 1978). See p. III-15 of the Instructor's Notebook. Better than any other concept, it simplifies and demystifies the functions of a computer and makes them intelligible to lay persons.

[12]Hoo-min D. Toong and Amar Gupta, "Personal Computers," Scientific American (December 1982), p. 87.

[13]See Public Works Manual 1986 (Ridgewood, NJ: Public Works Publications, April 1986), Section C, "Microcomputers and Software," by the author.

[14]MIS Week, January 27, 1986.

[15]Personal Computing, August 1984.

[16]PC Week, February 18, 1986.

[17]Norris and Webb, op. cit., pp. 2 and 7; and Donald F. Norris and David R. DiMartino, Computers and Small Local Governments: A Survey of Computing in the Plains and Mountain States, (Omaha: Center for Applied Urban Research, University of Nebraska at Omaha, August 1983), pp. 24-26.

[18]Thanks to John Scoggins for this quotable quote.

[19]Article by Scoggins forthcoming in ICMA's Municipal Yearbook 1986.

[20]Norris, "Microcomputers and Software," Public Works Manual 1986.

[21]InfoWorld, October 8, 1985; the additional categories are from Touche-Ross and Ernest and Whinney.

[22]Paul Chilrian, Beginning FORTH (Blue Ridge Summit, PA: TAB Books, 1984), p. 5.

[23]The IBM PC AT and compatibles, using the XENIX operating system, and the AT&T UNIX PC have been mentioned in the text as multi-user micros. Other multi-user units which may be appealing to local governments include the DEC Micro-Vax, the Data General Desktop Generation, the Burroughs B-26, and the Alpha Micro 1000 series. These and comparable devices from other manufacturers rely on proprietary operating systems, although some of them can run MS DOS concurrently. These machines were designed for multi-tasking, multi-user operation and, therefore, do not suffer the inherent limitations of essentially stand-alone machines. They are also supported by turnkey vendors and packaged software for local governments.

[24]This method and these steps, in one form or another, are used widely by information management specialists to assist organizations acquire computer technology. I was first introduced to them through the training and technical assistance program developed cooperatively by the International City Management Association and the Institute of Government of the University of Georgia. See Scoggins, Computers and Local Government Workshop. I have since modified and used these procedures in consulting and technical assistance projects with numerous local governments. They work.

[25]Among other things, in this chapter I report findings from case studies of the uses and effects of microcomputers in city governments that I conducted in 1985 and 1986. The case studies were made possible by a grant from the W. K. Kellogg Foundation.

[26] For an excellent examination of microcomputers as subjective objectives, see Sherry Turkle, The Second Self: Computers and the Human Spirit (New York: Simon and Schuster, 1984).

[27] See comments by Robert W. Pearson in the 1983-84 and 1984-85 Annual Reports of the Social Science Research Council; and James N. Danziger, "Social Science and the Impacts of Computer Technology," Social Science Quarterly (March 1985). In addition, during 1985 and 1986, Professor Lyke Thompson (Western Michigan University) and I directed an extensive bibliographic search to identify literature on the effects of computers. We found a small body of literature on the effects of computers in general and very little on the effects of microcomputers. Moreover, most of the material we found was speculative and prescriptive. Very little was based on empirical research.

[28] Lyke Thompson, "Local Office Automation Evaluation: The Case of Michigan's Department of Social Services," presented at the 1986 Annual Conference of the American Society for Public Administration, Anaheim, CA, April 1986.

[29] For example, see Kenneth L. Kraemer and James N. Danziger, "Computers and Control in the Work Environment," Public Administration Review (January/February 1984); and Rob Kling, Social Issues and Impacts of Computing: A Survey of North American Research (Irvine, CA: Public Policy Research Organization, University of California-Irvine, 1979).

[30] Thompson, op. cit., comments during presentation of the paper.

[31] For example, see Alana Northrop, William Dutton, and Kenneth L. Kraemer, "The Management of Computer Applications in Local Governments," Public Administration Review (May/June 1982).

# Appendix

## SOFTWARE LICENSE AGREEMENT

## Software License Agreement

This software license agreement, or something similar to it, is strongly recommended for governments that purchase packaged (as distinct from off-the-shelf) software. It provides adequate protection to both the vendor and the purchaser. Section X of the agreement imposes on the vendor the responsibility of ensuring an adequate machine configuration. Section XI allows the purchaser to return for a full refund any software with which he or she is dissatisfied within six months of purchase at no penalty.

This agreement was developed by American Fundware, Inc., of Steamboat Springs, Colorado, a vendor that sells and supports microcomputer software for governmental organizations. It is used here in modified form with permission.

# SOFTWARE LICENSE AGREEMENT

This program license agreement (hereafter "this agreement") is entered into by and between the VENDOR and the LICENSEE:

I. Grant of License, Agreement to Provide Related Materials and Related Services. In consideration for Licensee's payment of the one-time license fee, but subject to all of the terms, conditions, and limitations of this agreement, Vendor grants to Licensee the personal, non-exclusive, non-transferable right to use the current release as of this date of the licensed program in machine readable form and the right to use the related materials, defined below, on or in connection with the central processing unit of the designated computer system. In further consideration for such one-time license fee, Vendor agrees to provide the related services defined below.

II. Definitions.

A. The "licensed program" shall mean the specific application programs(s) listed in Section XIV, in machine readable form. "Licensed program" shall further include all new or additional releases made by Vendor to the licensed program during the one-year period following the delivery date of the current release.

B. "Related materials" shall mean all other materials furnished by Vendor and officially released pertaining to the licensed program including, for example, instructional documentation, user and operational guides, and training guides.

C. "Related services" shall include:

(1) Installation support and training of Licensee's employees in the use of the licensed program at the (vendor or licensee location) for the number of days during the first year set forth above. Related services does not include training or retraining of Licensee's employees with respect to general data processing concepts, machine operations, keypunch training, system security, and/or backup procedures; and

(2) Software support, maintenance, and any necessary telephone consultations, for one year commencing on the delivery date.

III. Additional Charges. The one-time license fee shall not include the following, all of which shall be paid by Licensee as additional charges:

A. A fee for time expended by Vendor's employees, at a reasonable hourly rate, for training or retraining Licensee's employees in the use of the licensed program after the initial installation support;

B. Per diem at ______________ per day, plus travel and lodging expenses of Vendor's employees, for the on-site support after the initial training specified above;

C. Direct costs of transmitting new releases of or changes to the licensed program, except those necessitated by defects in the current release;

D. Telephone charges;

E. Programming fees at current rates for any modification to the licensed program requested by Licensee and agreed to be performed by Vendor not necessitated by defects in the licensed program.

IV. <u>Term</u>. The license herein granted shall be perpetual and shall be terminable by Vendor or by Licensee only upon the terms and conditions set forth in this agreement.

V. <u>Defects in Licensed Program</u>. During the first year of Licensee's use of the licensed program, Vendor will provide programming services, without additional charge for time or out-of-pocket expenses, to correct the unaltered current release of the licensed program if it shall contain any error, malfunction, or defect. Licensee agrees to advise Vendor in writing of the precise nature of any suspected error, malfunction, or defect and to provide Vendor with all relevant information upon request in order that Vendor may render such programming services.

VI. <u>Use of Licensed Program by Licensee</u>. Licensee shall use the licensed program only for its own purposes and not in service on a fee basis for any other person, entity, or governmental unit. Use of the licensed program on any additional computer equipment (other than a unit installed in complete substitution for the central processing unit) shall require payment of an additional license fee. Licensee shall not copy the licensed program in whole or in part except for safekeeping and backup purposes. Only the number of machine readable copies of the licensed program that are necessary for such backup purposes will be in existence on or off the Licensee's premises at any one time. Licensee is granted only the use of the licensed program, and such program shall remain the property of Vendor. Licensee shall never assign, transfer, convey, or give the licensed program or related materials to any party, nor shall it disclose the licensed program or related materials or any portion or aspect thereof to any party.

VII. Licensee's Employees. Licensee's employees will have access to the licensed program and related materials. Licensee agrees that it will, prior to making the licensed program and related materials available to any employee, obtain reasonable assurance from each employee that they will not disclose or convey any release of the licensed program or related materials or any aspect thereof to any person or entity.

VIII. Security. Licensee agrees that it will take reasonable steps to secure the licensed program and related materials from theft, destruction, and unauthorized disclosure.

IX. Responsibilities of Licensee. Licensee shall be exclusively responsible for the supervision, management, and control of its use of the licensed program, including but not limited to (a) establishing adequate backup plans, (b) insuring access to qualified Vendor programming personnel to assist Vendor in diagnosing, patching, and repairing licensed program defects in the event of a program malfunction; and (c) implementing sufficient procedures and check points to satisfy the requirements for security and accuracy of report and output as well as restart and recovery in the event of a malfunction.

X. Responsibilities of Vendor. Vendor shall ensure the proper machine configuration, shall install all licensed programming, and shall provide __________ days of user and management training for Licensee personnel in the operation of all licensed programs. In the event the machine configuration shall be inadequate to run the application programs and their data bases as specified in Section XIV, Vendor will at no cost to Licensee add such increments of memory or disk storage to the system as required to make it run said programming and data bases.

XI. Warranty and Limitation of Liability. If Licensee is dissatisfied with the licensed program or related materials after reasonable efforts at using them, then Licensee may, at its discretion during the six-month period commencing on the actual delivery date, return all copies of the licensed program and related materials to Vendor and receive a full refund of the one-time license fee, after deduction of any charges then outstanding and payable from Licensee to Vendor. Notwithstanding such return, Licensee and its employees shall continuously remain liable under their covenants not to convey, assign, donate, or disclose the licensed program and related materials and the provisions of this agreement for Vendor's damages. After the return of the licensed program and related materials, Licensee's right to use the licensed program and related materials or any aspect or derivative thereof shall cease.

Licensee and those claiming under Licensee specifically agree that their sole and exclusive remedies under this agreement shall be reimbursement to Licensee of the one-time license fee. In no event shall Vendor be liable to Licensee or any third parties for loss of profits or other economic loss, or for any indirect, special, consequential, or other similar damages, arising out of any breach of this agreement or malfunction of the licensed program, even if Vendor has been advised of the possibility of such consequential damages.

XII. Hardware Supplied by Licensee: Any new hardware supplied by Licensee under this license agreement shall be subject to the specific manufacturers' warranties only and not those of Vendor. Any used hardware supplied by Licensee under this license agreement shall not be subject to any warranties unless expressly written and attached to and made part of this lease agreement by all parties.

XIII. Complete Agreement. Vendor and Licensee acknowledge that they have read this agreement, understand it, and agree to be bound by its terms. The parties agree that this agreement is the complete and exclusive statement of the agreement between them, and that it also includes as an integral part hereto Licensee's Request for Proposal dated ______________________, Vendor's Proposal dated ______________________________ (as amended by ______________________) and correspondence dated ______________________ between Vendor and Licensee.

XIV. List of Licensed Programs Purchased by Licensee.

1. __________
2. __________
3. __________
4. __________

etc.

Signed

| VENDOR: | LICENSEE: |
|---|---|
| By: __________________________ | By: __________________________ |
| Date: ________________________ | Date: ________________________ |