THE EXECUTIVE'S HANDBOOK TO

MINICOMPUTERS

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The Executive's Handbook to Minicomputers

TO RUTH,

Who has taught me to live my dreams

PREFACE

The Executive's Handbook to Minicomputers was written for the business executive as a guide to the proper selection and application of minicomputer systems. Using simple business language, it conveys to the decision maker the structure and operation of the components of minicomputer systems.

This handbook is organized in an easy-to-follow, question-and-answer format. Use it as you would a consultant. You have only to look for your question in the Contents, then turn to the appropriate pages for your answer.

At the end of each chapter is a section entitled "Selection criteria". Five separate applications of minicomputers are outlined in the section's first appearance at the end of Chapter 1, applications which are intended as examples of how to select and apply minicomputer components effectively. Each application is studied, with respect to selecting the minicomputer component reviewed in the text. You will find that

the choice of applications is broad enough to cover many of the requirements that arise in your own application.

This handbook concludes with an extensive glossary of the most commonly used minicomputer terms.

The *Executive's Handbook* is intended as a reference source to be used in purchasing and applying minicomputer systems from among what must seem an almost limitless choice of vendors. The information contained in these pages will help you narrow the field and make the correct decision in a timely manner.

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THE UNBUNDLED NATURE OF MINICOMPUTER SYSTEMS

Minicomputers have become part of the business community. They have: added to the bottom line, made more information more widely available, increased product bases, and breathed life into a new and exciting style of business. This style is characterized by the interaction of man and machine in servicing clients, increasing productivity, forecasting trends, and sharpening the management process.

As a manager you are being exposed to minicomputers more and more each day. You can see their growing application and effectiveness. But can your business profit from their use? To answer this question, you must first understand what minicomputers are all about.

What is a minicomputer?

How often have you asked the question, what is a minicomputer? And how many answers have you gotten that make you wish you had never asked? Due to the dramatic changes in minicomputer technology that have occurred in recent years, defining a minicomputer is difficult. What was a good interpretation yesterday is no longer meaningful today. But there *is* a definition that makes contemporary sense. We will find it by reviewing what the early minicomputer was and learning how it has changed.

We begin by rephrasing the question above: What *was* a minicomputer? In the early 1960s small computers were designed and built for special purposes. These products consisted of electronic circuitry engineered to produce specific responses to predictable sets of input data. Their principal use was in aerospace instrumentation and related sciences. It wasn't until the middle of the decade that a small, general-purpose, data-processing tool was introduced. The new device was capable of acting on a logical set of instructions in performing operations involving quantities, quantities that were represented electronically as binary digits. Different sets of instructions could direct a machine to respond in various ways. The same (or different) sets of input data produced differing results, depending on the set of instructions which the new computer was operating on. The input data was either predictable or unknown.

The only difference between the announced computer and the standard, general-purpose computer of that generation was their relative size and power. The new device had fewer instructions, less memory capacity, and almost no available peripheral components. Hence, because of its smaller size, it was called a *minicomputer.*

As a business manager you would have viewed the early minicomputer as a promising tool, though hardly suitable for major information-processing. The first minicomputer systems were comprised only of the minicomputer itself; that is, they contained an instruction processor and some memory. In addition to the minicomputer, the early systems included a panel of switches and lights. This panel was known as the "programmer's panel" because it was used to transfer information between human and minicomputer. The early user had to translate each instruction of his program into a string of binary digits, then, by

positioning the switches up or down, enter the information in the minicomputer's memory. There was no accepted standard, though placing a switch in the "down" position usually indicated a binary one. The "up" position represented a binary zero. This convention, however, varied among early manufacturers.

After a program had been entered in the minicomputer's memory, the user would request its execution by activating another switch. The result of this operation would then be interpreted in the pattern of lights displayed on the programmer's panel. A light that was "on" represented a binary one (1), while a light that was "off" indicated a binary zero (0). It was obvious that a verbal means of interchange between man and machine was needed before the business community would accept the minicomputer.

The first improvement in minicomputer technology answered the need for verbal communication. This development was the connection of a teletypewriter to the minicomputer. As its name implies, the teletypewriter—commonly called a "teletype"—is a typewriter capable of telecommunications. This means it is capable of transmitting and receiving symbols electronically. The Teletype, which is still in use today, has a keyboard similar to that of an office typewriter. The keyboard is used by an operator for entering information in the minicomputer. The result of the minicomputer's operation is displayed on a roll of paper by a mechanism for printing characters. The minicomputer user now had a device that made it possible for him to represent instructions with alphanumeric symbols. He could also see the results of his program displayed verbally.

Optionally built into the body of the Teletype is a device capable of storing information outside the minicomputer's memory. The device records information on a narrow papertape by punching a coded sequence of tiny holes which represent alphanumeric, or binary, data. The device, called a papertape reader-punch, can also read punched papertape and transfer information to the minicomputer. Although many variations of the papertape reader-punch have been developed, the Teletype version is still the least expensive. Minicomputer systems could now store information for later processing, and early users were able to exchange data with other users and other minicomputer systems by passing a papertape.

So far we have looked only at the machinery used in early minicomputer systems. Computer machinery is called *hardware,* a word I'm sure

you have heard. For the minicomputer's hardware to function, however, it had to be programmed. The programming of computer hardware is referred to as *software.* You are probably familiar with this word as well. The next step in our review of the minicomputer is to understand *how* it was programmed.

All of the software for early minicomputers was developed by organizing strings of binary digits, representing machine instructions, into a logical sequence. This style of programming was called "machine language programming"—*machine* because of the binary representation of instructions, and *language* because it was a means of communicating with the minicomputer.

The first improvement in minicomputer software paralleled the attachment of the Teletype, by relieving the burden of programming in machine language. This improvement provided the software necessary for symbolic communications, as well as the means for representing machine instructions with alphanumeric symbols. A new style of programming emerged, called *symbolic programming,* while the software was called a *symbolic programming language.*

Additional software was necessary for the minicomputer to understand the user's symbolic instructions. A program called "text editor" was developed, which controlled the input of symbolic programs. As the term implies, this program was used both to modify old programs and to enter new ones. When the user completed his editing session, he would ask the system to output a papertape containing the symbolic code. This tape became known as the "symbolic tape." All the software necessary for controlling the operation of the minicomputer system's hardware was designed into the text editor. It included the instructions that enabled the Teletype and papertape reader-punch to operate as requested.

After the symbolic tape was punched, the programmer would use it as input to another program. The function of the second program was to assemble the symbolic instructions into machine language. Appropriately, this program was called the *assembler* and the symbolic programming language, the "assembler language."

The output of the assembly process was made up of a paper tape and a printed listing. The paper tape contained a sequence of holes which represented binary data, and was known as the object tape. The listing displayed both the symbolic instructions and the machine language instructions they generated. As was the case with the text editor,

the assembler contained all the software needed for Teletype and papertape reader-punch operation.

Early minicomputer memory wasn't large enough to hold both the text editor and the assembler at the same time, so it was necessary for the programmer to load the text editor to prepare a symbolic program, and then load the assembler to prepare the object program. The object program on papertape was then loaded into the minicomputer's memory for execution. A third program, called the *loader,* was used for this purpose. The programmer had to enter a "preloader" into the minicomputer's memory through the programmer's panel. The preloader would control the Teletype and papertape reader-punch for the purpose of entering the loader into memory. The loader took over and controlled loading object programs into the minicomputer's memory. The text editor and assembler were supplied as object tapes, and the loader was used to enter them into memory. Obviously the job of program preparation was long and tiresome.

The early minicomputer had little capacity and limited functionality, in addition to being a burden to program. Its low price tag and inventive appeal, however, made it attractive to both scientists and engineers. (We are experiencing the same phenomenon today with microcomputers. Throughout this book you will see how minicomputer systems have taken advantage of microcomputer technology.) Thus it came as no surprise that one of the first applications of the minicomputer was in the laboratory. It could perform great volumes of complex calculations at a fraction of the cost of larger computers. Because it was dedicated to their application, the minicomputer could also provide its users with all the computer time they wanted.

Creative users of the early minicomputer overcame its burdens and limitations, and made its application a huge success. Early minicomputer systems were used to maintain experiment records, print reports, keep track of laboratory operations, and so forth. The minicomputer was becoming recognized as more than just a low-cost tool for evaluating equations.

As you know, news travels fast in the business world; news of a product with the potential of lowering operating costs travels fastest. The success of the minicomputer was no exception, and demand for its application grew in all areas of business. Minicomputer technology was about to undergo explosive growth as the minicomputer manufacturers readied for competition in a vast new market. The minicomputer

had to be easier to program, and its size and power needed to be expanded. Its communication capabilities had to be improved. Manufacturers responded, and soon the minicomputer was bigger, faster, and more conversant with man.

The years 1970 to 1975 were a period of tremendous growth in minicomputer technology. By the latter date the minicomputer industry had come to be recognized as one of the surest investments possible. Minicomputers were successfully applied to energy production and distribution, to traffic control, flight simulation, plant control, and general business information-processing and -reporting. During these years the financial community looked to the minicomputer as a means of stabilizing or reducing their operating costs. Most data-processing applications in this area required the maintenance of large data bases, high volumes of quality printed reports, and responsive servicing of many terminal operators. Software for such applications had to be easy to maintain and modify. The minicomputer industry responded with numerous advances in software, magnetic storage equipment, and terminal products. FORTRAN, BASIC, and COBOL—programming languages that were more verbally descriptive and less machine-oriented than assembler—were adapted and expanded for use on minicomputers. The aggressive business manager was soon applying minicomputer systems in all phases of his company operations. As companies' data-processing costs began to drop, the minicomputer became a strong challenger to large computers in every business-management application.

Now that we've come this far, ask again: What is a minicomputer? At the beginning of this brief summary, we could answer this question with regard to the minicomputer's *size;* but we can no longer use size alone as the basis of a definition. In fact, the prefix *mini* is questionable. Fortunately, there is more history to cover. As we continue, we will observe something about how minicomputers are sold. Our observation will provide a basis for defining a minicomputer accurately.

The rapidly growing market for minicomputers attracted both investors and inventors. Soon there were more than ten major minicomputer manufacturers in the United States, along with hundreds of companies offering related products. As you would expect, the minicomputer industry became an arena of fierce competition. To succeed in such an industry, minicomputer manufacturers developed a simple strategy: attract a prospect to a feature, or features, of a component of