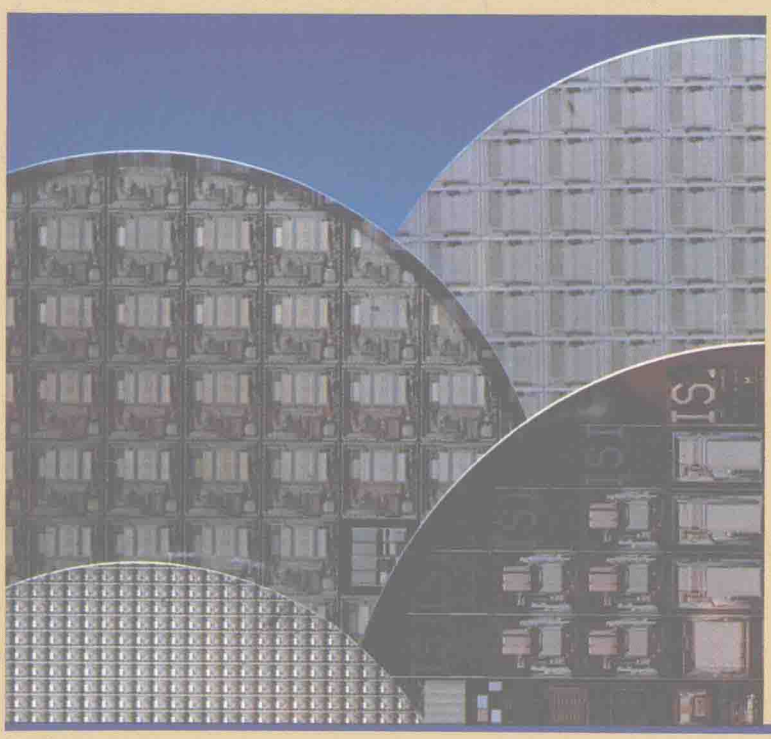
VOLUME I

Concepts and Issues in Health Care Computing

COVVEY / CRAVEN / McALISTER



COMPUTERS IN HEALTH CARE

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Concepts and Issues in Health Care Computing

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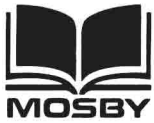

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TO

Dr. William Cass,
Dr. R. M. Cherniack,
and **Dr. John Toogood,**
who helped us bring computers
and medicine together

PREFACE

The computer is becoming increasingly more commonplace in the practice of health care. We find desktop computers in many hospital departments and physicians' offices, and we see the number of hospital information systems growing. In the last decade the health care field has begun to realize the potential benefits of computerization that business and industry were the first to discover.

Unfortunately, health care professionals often have not had the training to use computers effectively or to make decisions on how computers might aid them. The books in this series will try to provide this necessary information. They will be useful for physicians, dentists, nurses, hospital administrators, laboratory personnel, and students who expect to use computers in their health care careers. The goals are to make readers comfortable with this new technology and to address some of the important issues in health care computing.

Perhaps the most cogent reason for health care professionals to become at ease and competent with computer systems is to retain control. If control over the employment of computers is in the hands of the health care professional, then there is good reason to believe the computers will be applied in the right areas and in the most productive ways. Alternatively, the technology will be in the hands of the technocrat and the nonmedical expert, resulting in what we believe will be a deleterious effect on both personnel and health care itself.

This book, the first in the series, describes computing machinery and concepts of programming, along with considerations in implementing computer systems in the health care environment. Lists of people and current books and journals in health care computing, as well as magazines and journals reviewing computer systems, appear in the appendices. A glossary is also included.

The reader will notice that each chapter is preceded by a schematic diagram of a computer system. In some chapters these areas are shaded to indicate topics covered in those chapters. We hope that use of this block diagram will help the reader see computers from a systems viewpoint (i.e., an integrated whole composed of many parts).

We hope this book will also be useful to computer specialists, although the technical details will be familiar to them. The special problems faced by health care professionals and the unique features of health care systems will give computer scientists a clearer picture of health care computing as a separate academic field and perhaps stimulate students' interest in this exciting career area.

We wish to acknowledge the assistance of Bill Gruener in helping to make this book possible, Nancy Mullins for her advice and encouragement, Maureen Slaten for her suggestions, and Pat Miller for her efforts above and beyond the call of secretarial duty.

H. Dominic Covvey
Nancy H. Craven
Neil H. McAlister

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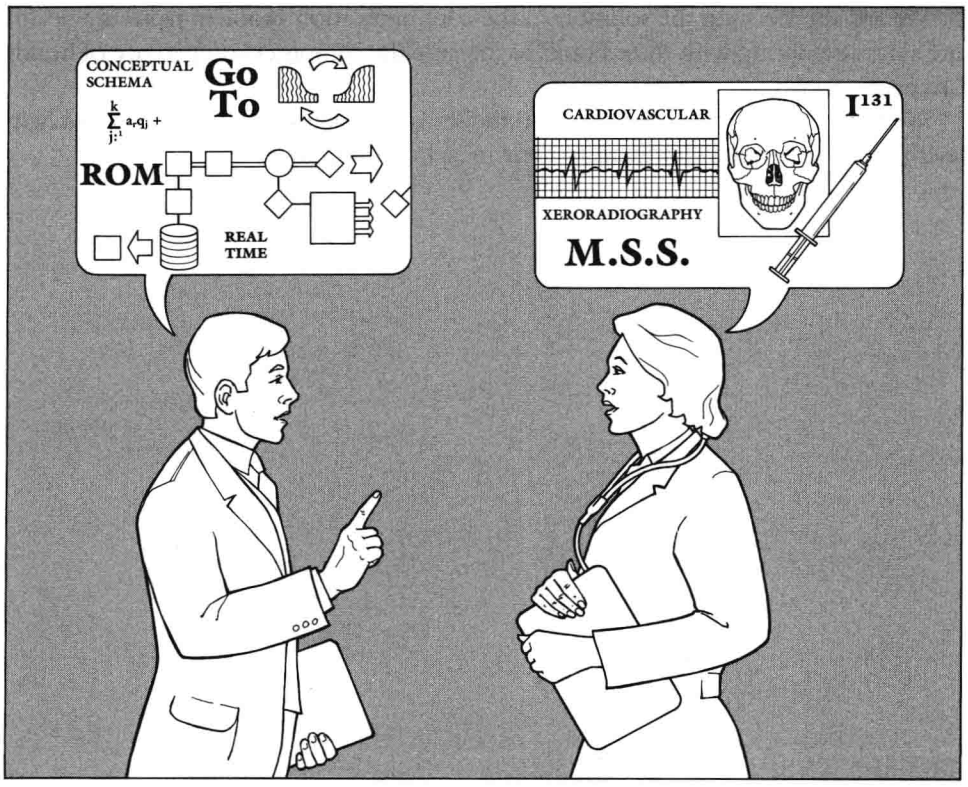
INTRODUCTION

Health care computing has changed dramatically over the last 15 years, partly because of changes in the capabilities of computer hardware, and partly because of an increasing understanding by the health care community of the potential benefits of computerization for health care.

In the 1960s computers first appeared in hospital business offices and research laboratories. These large machines were used mainly for "number crunching" purposes and were largely isolated from the patient care areas. Gradually an awareness

FIGURE I-1
The communication gap.



developed that computers might also be useful in other areas, and we began to see a few examples of this new technology in admitting departments, intensive care units, and clinical laboratories in the early 1970s.

It was unfortunate, in a sense, that computers were becoming a status symbol in the world outside the hospital, because this attitude also became predominant in the hospital. Thus, a large number of computers were brought into health care areas without serious consideration of their impact.

Now it seems that the health care community is becoming more realistic in its expectations of computers. As computers have become commonplace in our everyday lives, we realize they are simply a tool to make certain tedious tasks easier to do. And we are beginning to understand that a computer is not the solution to every problem.

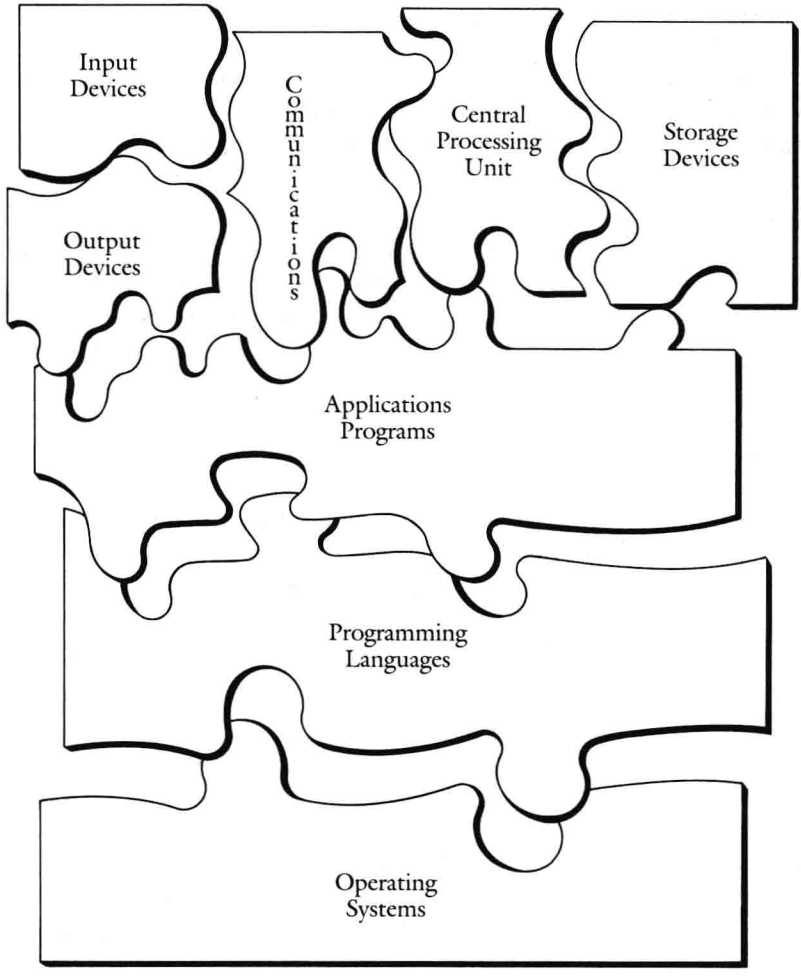
A communication gap now exists between health care and computer science. On the one side are the physicians, nurses, and other health care professionals who feel that computers may somehow help them in their work, but who do not understand enough about these machines to approach them intelligently. On the other side are the computer professionals who fully understand computers, but who find health care so inscrutable that they do not know how their computing skills might assist in solving current health care problems, or even what these problems are (Figure I-1).

We are approaching the solution to the communication problem from the health care side, attempting with these books to increase the computer competence of health care professionals.

We hope this book and the others in the series will demystify computers and help health care professionals to identify their uses and limitations.

CHAPTER 1

COMPUTER SYSTEMS



OBJECTIVES

Prerequisite to effectively using computers to solve problems in the health care environment is establishing appropriate **computer systems** in that environment. Using the term "system" is important, for it implies a rational mixture of integrated parts working synergistically to form a useful whole. To gain a basic understanding of the "gross anatomy" of computer systems, it is helpful to separate these systems, somewhat artificially, into components. We will do this in the current section.

What are the parts that make up a computer system? Broadly speaking, a computer system is composed of three parts.

The first part is **hardware**—the physical, electronic, and electromechanical devices that we instantly recognize and think of as computers. The second part is **software**—the programs that control and coordinate the activities of the computer hardware and that direct data processing. The third part, and the most important, is people. We will discuss people in later chapters.

The success or failure of any computer system depends on the skill with which these components are selected and blended. Too frequently, critical decisions regarding the selection and acquisition of components of the computer system for health care use are determined either by random chance or by the persuasion of computer salespersons. Some users are lucky and do obtain useful systems in this manner, but inevitably many others are not so lucky. A poorly chosen system can be a monstrosity incapable of performing the tasks for which it was originally acquired. The danger of such a system is not only failure but also significant financial loss.

Physicians, nurses, administrators, and technicians who perceive problems, either in patient care or in health care research, are often the first to consider that a computer might be helpful in solving these problems. How, then, is a health care professional to plan and direct a computer project that he or she has initiated and help bring it to successful completion? Part of the answer is learning enough about computer hardware, software, and the roles of the people who use these systems to feel comfortable and competent with the jargon and the way of thinking that goes with these systems. We will discuss these in the first chapters. In fact, we would be truer to our concerns if we reversed the order and talked first about people, then about software, and finally about hardware, because hardware is the least important component of the solution. We must, however, first demystify the technical parts of the system.

In the discussion of hardware components and types of software, a rather loose metaphor of evolution is followed. The development of the various components of a computer system has been in some ways a story of the survival of the fittest. At any particular time, the "fittest" component is the one that provides the best performance at the lowest cost. Over the decades that computers have been in existence, advancing technology and automation theory have rendered obsolete a number of devices or concepts. On the other hand, machines and theories that have been able to respond to

"evolutionary pressures" have proliferated and given rise to numerous more sophisticated descendents.

Whether evolving computer science theory (which often precedes reality by many years) has actually provided the impetus for new developments in hardware and software, or whether computer scientists have mainly figured out what to do with technology after it has been made available, is a matter of debate—perhaps never to be resolved. One can only observe that the technological imperative often leads to remarkable technical developments in the absence of any justifiable need.

Undeniably, computers are subject to possible abuse. They can make possible a delivery system for nuclear weapons, or they can be used to violate our right to privacy. On the other hand, in the health care field, computers can potentially provide one of the most productive applications of technology for the betterment of humankind.

The evolutionary pressures at work in the health care environment today seem to be concerned mainly with money. Therefore, in the long run the role of computers in health care may be dictated by the degree to which they can demonstrably reduce costs (as opposed to improve the quality of patient care). So far they have not been particularly successful in this regard. However, evolution is at work, and only time will yield the final verdict.

The health care–computer user must know some computer system theory and also where and how these systems can be obtained. Therefore we shall give some attention to the practical considerations of selecting, pricing, and obtaining hardware and software. We may be in a fairly stable period in total computer system cost. Although the cost of hardware has been declining in the past several years, labor costs—and consequently, the cost of software development—have been increasing at the same time. Therefore, the total cost of the complete computer system (both hardware and software) has leveled out and probably will not decline much further (Figure 1-1).

A computer system does not exist in a vacuum. It is always a part of a larger human "system"—less easily defined, but no less real than computer hardware and software components. For instance, some computer systems serve as part of an instrument, such as in a computerized tomography (CT) scanner. To be useful, such computers are carefully interfaced with the instrument, appropriately programmed, and expected to work in synergy with the other parts of the instrument. Other computers are integrated into departments or institutions such as hospitals. These computers must function in this large milieu in ways analogous to how they function in an instrument. In the largest applications, a computer system may be only one component of a very large network. In short, a computer system should never be considered in isolation. Its success or failure is measured by its success in the situation in which it is used.

Therefore, if computer systems are to serve health care needs they must be carefully integrated into the human and procedural domain they are intended to improve.

The computer system cannot do all the adapting, though. The human milieu must also be groomed to accept the computer system. People's fears, concerns, and even anger must be faced and rationalized. A delicate balance will be struck between the human engineering of computer systems and educating potential users to make realistic, attainable demands on such systems.

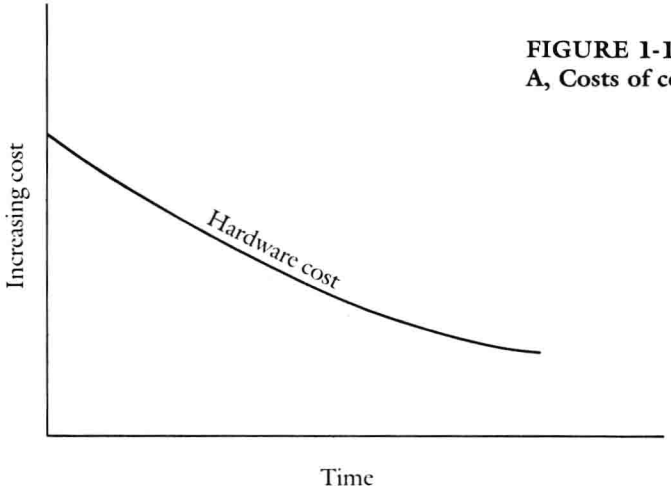
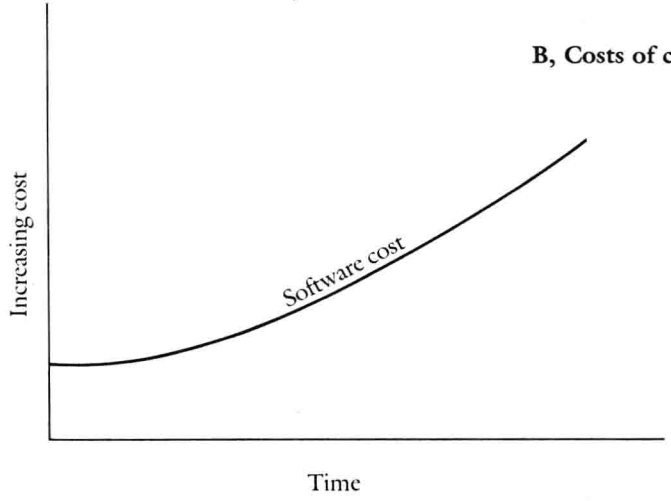


FIGURE 1-1
A, Costs of computer hardware systems.



B, Costs of computer software systems.

THE COMPUTER CONFIGURATION

HARDWARE

Figure 1-2 shows schematically the fundamental components of computer hardware joined together in a computer system. The centerpiece is variously called the **computer,** the **processor,** or usually the **central processing unit (CPU).** We use the term "CPU" to include those parts of the hardware in which calculations and other data manipulations are performed (the **arithmetic logic unit**) and those parts that control the sequence of instructions (the **control unit**). Associated with the CPU is an **internal memory,** in which data and instructions are stored during the actual execution of programs. These components are normally housed in the same enclosure; it makes sense to think of them together. Attached to the CPU are the various **peripheral devices. Input devices** are used to enter data or programs into the computer for processing. Punched-card readers and keyboards are two common examples of input devices. After processing data, the computer gives its answers back to us through **output devices;** printers and videoscreens are two examples. When data or programs must be saved for long periods of time, they are stored on various **secondary memory devices** (or **storage devices**)—magnetic tape or magnetic disk, for instance.

Peripheral devices are usually electromechanical, and as such their rate of performance is many orders of magnitude slower than the purely electronic circuits of the computer itself. Because of this reason, input, output, and storage operations are often the rate-limiting operations in computer data processing. In a personal com-

FIGURE 1-2
Hardware components of a basic computer system.