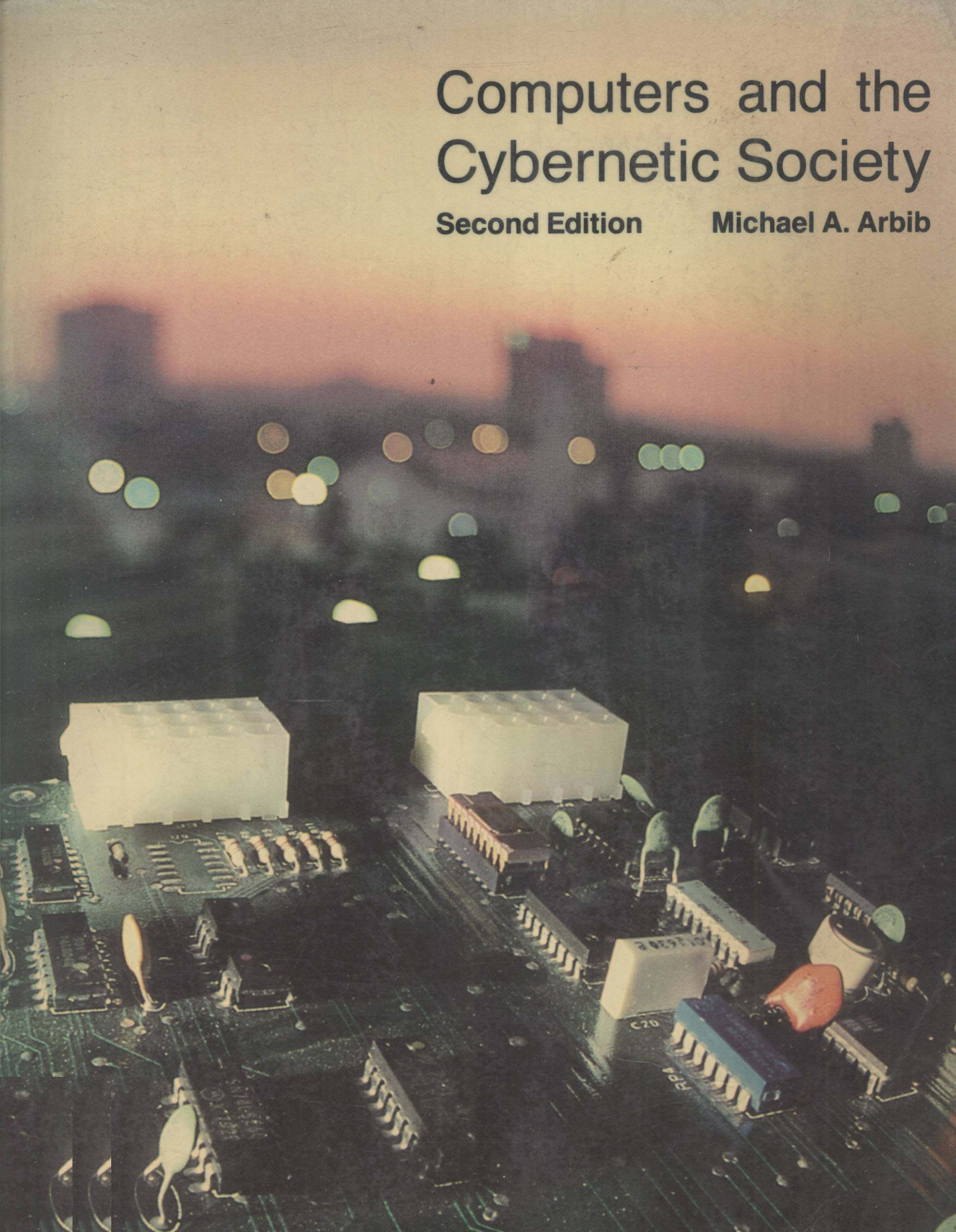


# Computers and the Cybernetic Society

Second Edition

Michael A. Arbib



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# **PREFACE**

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The first edition of this book was written in 1975 and predicted that personal computers would become common “sometime in the 1980s.” The prediction was correct, but conservative—1980 marked the turning point for the introduction of computers into the households of the Western world. In preparing the second edition, I have tried to address this and other dramatic developments in computers by updating the book where necessary and by including discussions at appropriate points of such increasingly important topics as expert systems, management applications, and office automation. In addition, to help students in reviewing material, the glossaries that appeared at the end of the individual sections in the old edition have been gathered into one large glossary at the end of this volume. To help readers further explore their own interests, I have greatly expanded and updated the Suggestions for Further Reading at the end of each section. I hope that all of these changes will enhance the value of the book to student and instructor alike.

## **TO THE INSTRUCTOR**

There seem to be two extremes in books on computers and society. At one extreme, there is the book that loads down its readers with so many details about how computers work that they have neither the time nor the energy left to examine the social implications. At the other extreme, there is the book that tells its readers so many different effects that computers are having on their lives that it is impossible to discern any pattern in the details. This book tries to strike a balance. The first chapter is intended to help place your students' study of computers within a societal perspective. Chapters 2 and 3 provide a basic understanding of computers and programming. The next five chapters give a comprehensive overview of the impact computers have on the cybernetic society. A final chapter is intended for just a few readers—those who desire a step-by-step view of how computer circuitry can follow the instructions we give the computer—and is not essential to the book's overall coherency.

One of the toughest questions in setting up a course on computers and society is deciding on how much programming to include. My feeling is that

Chapter 2 provides the absolute minimum of programming concepts, while Chapter 3 provides key concepts—graphics, networks, microcomputers, and program design—essential for any serious discussion of what computers can do. Some of you will find that this is enough. Others will want to teach a “real” programming language, like BASIC. Such instructors will find it convenient to supplement this book with a user’s manual for the particular “dialect” of BASIC in use at their institution.

Excluding Chapter 1, which is not divided into sections, this book contains 25 sections. For the most part, the material in a section can be covered in one lecture or be extended to constitute two. The first lecture should give an overview of the course, based upon Chapter 1, and should be followed by the presentation of Sections 2.1 and 2.2. Other than that, the order of presentation is very flexible.

You may omit sections in order to bring in guest speakers, add supplementary material, or devote more time to programming. The abstracts at the beginning of each chapter outline the section prerequisites and will aid you in formulating your schedule.

This flexibility of scheduling and the inclusion of such features as the Summary, Glossary Words, Exercises, and Suggestions for Further Reading should make the book an easy one from which to teach. A supplementary *Instructor’s Manual* has been prepared to provide further assistance. The *Manual* is divided into sections, one for each section of the text. Each section is divided into three parts. The first part provides some observations on classroom use of the section. The second part provides solutions to a selection of the exercises from the text itself. The third part provides additional questions—some with answers—suitable for use in tests or examinations. In addition, the second and third parts also contain further suggestions for classroom discussion.

In a changing field like this one, it is a continuing challenge to keep the material in a textbook lively and current so that breathtaking glimpses of the future do not degenerate into tired repetitions of the past. Hopefully, the choice of topics in this book provides a solid foundation of material that will not become rapidly dated. When material culled from current publications and the work of your colleagues is added to this foundation, it should be possible to keep your students apprised of the latest developments.

So that future editions may reflect our cumulative successes and avoid our cumulative mistakes, any feedback you can give me will be greatly appreciated. It is my hope that through our efforts our students will gain a sound perspective on both computer technology and its implications for the cybernetic society.



## ACKNOWLEDGMENTS

My greatest debt in the preparation of this volume is to Jeffery Bonar, who updated the *Instructor's Manual* and provided valuable suggestions for a number of improvements.

Much of the merit of this book comes from the generosity of friends and colleagues who offered the expertise I needed to cover the broad range of topics treated here. My heartfelt thanks go to Maggie Boden, Caxton Foster, Harvey Friedman, Robert Graham, William Kilmer, Rob Kling, Henry Ledger, Jack Lochhead, Michael Marcotty, Howard Peelle, Richard Reiss, Edward Riseman, Kenan Sahin, Alvy Ray Smith III, David Stemple, Robert Taylor, Andy van Dam, Jack Wiledner, and to many others.

I would also like to express my gratitude to the reviewers. Their careful reading and thoughtful comments were instrumental in shaping the final draft of the manuscript.

The photographs in this book were generously provided by Kevin Deame (The Squirrel Nebula), the Digital Equipment Corporation (The Shrinking Machine), Paul Tenczar (PLATO Computer-Assisted Instruction), and Thomas Dwyer (Project SOLOWORKS). Special thanks are also owed to Paul Bennett and the Technical Information Division of NASA's Ames Research Center for their aid in locating and obtaining many other photographs used in this book.

Many of the exercises were prepared for the first edition by Jonathan Post. I thank Jon for his invaluable help with this task.

Gwyn Mitchell, Barbara Nestingen, Joyce Rodriguez, Janet Turnbull, and Rae Ann Weymouth did a fine job typing the manuscript of this book.

Finally, I want to thank the personnel of Academic Press for their exceptionally constructive role in the development of this textbook.

Michael A. Arbib  
Amherst  
March, 1983

# TO THE STUDENT

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## What This Book Is About

Increasingly, computers affect our lives. They communicate, store and retrieve information, and carry out the complex procedures of problem solving in an impressive array of fields and endeavors. Our bills, checking accounts, and income-tax returns are all processed by computers. The data banks in which government agencies and credit-card companies store information about us are computer based. Computer-assisted instruction affects the way in which we learn and automation affects the way in which we work. Governments use computers in economic planning. Environmentalists use them to study ecological systems. And the use of miniaturized computers in everything from video games to driving the display of a digital wristwatch to controlling the ignition of a car is rapidly increasing. Moreover, millions of families now have computers in their own homes.

This book was written to explain the impact the computer has on you today and to provide you with the knowledge you need to help decide how computers will be used in the future. For this, you need to know what computers are and how they are programmed; that is, how they can be given instructions to make them perform the jobs described above. Once you have this basic understanding, you can become involved in the many applications of computers and form your own opinions concerning their appropriate uses and necessary restrictions.

This book can be used for self-study and in a variety of classroom situations, as well. It is most suited to junior-college or college courses on computer literacy or computers and society, but with the growing availability of personal computers in the high schools, it may prove increasingly useful in the secondary education setting. But before I describe how you and your instructors can use the book, we should first briefly examine the meaning of the word *cybernetic* as it is used in the title *Computers and the Cybernetic Society*.

The current usage of the word *cybernetics* was introduced in 1948 by Norbert Wiener of the Massachusetts Institute of Technology. He had been struck by similarities between the ways in which some machines work and the functioning of a living body. For example, a steam engine has a device called a governor that keeps the engine from running too fast or too slow. Scientists had compared this process to the way in which the brain of an

animal regulates the heart and lungs in an effort to keep the proper amount of oxygen in the blood. Wiener felt that such comparisons between animals and machines deserved systematic study. He gave the name **cybernetics** to *the study of control and communication that compares functions in the animal and the machine*. The word cybernetics comes from the Greek word *kybernetes*, which means *helmsman*: the individual who controls the direction of a ship. The word governor is taken from the Latin form of *kybernetes*; thus, the political aspects of control are contained in the history of the word. Since 1948, many scientists have applied cybernetic principles not only to the study of communication and control within *individual* animals or machines but also to these functions within *groups* of people, animals, and machines.

The **cybernetic society**, then, is one in which people and computers interact in processing large amounts of information. This book will help you to understand this interaction and how it can be used to improve the quality of life. To achieve this goal, we must continually study both computer questions—How do we make a computer do a particular job?—and social and political questions—What job should we make the computer do? For example, a government needs a great deal of information about its citizens if it is to do such things as check the accuracy of their tax returns and call up the right people for military service. This information can be stored in a computer in a large “electronic file system” called a **data bank**. The existence of these data banks raises many political and social questions: What information should the government be allowed to store in a data bank? What rights do citizens have in correcting or removing information about themselves? Who should be allowed to get information from the data banks? Who should decide such matters? We cannot discuss these questions without knowing at least the answers to such basic questions as: How does a data bank work? How can you make sure that only the “right people” have access to the information stored in it?

The most important fact to remember as you read this book is that modern computers are only about 40 years old. The next 40 years will see such dramatic changes that most of what we describe here will come to seem quaint and old fashioned. Consequently, it is not enough for this book to teach you about the contemporary state of the cybernetic society. Its more important function is to help you to understand how computers will dramatically change our lifestyles in the future.

## How This Book Is Organized

This book has been written so that many of the sections can be understood without a thorough knowledge of the information contained in earlier chap-



ters. Chapter 1 will alert you to a number of social issues raised by computer developments. Then, once you have read the introduction to computers and programs given in Chapters 2 and 3, you will be able to turn to any other chapter and read it with little difficulty.

The first page or two of each chapter will help you decide which sections you want to read. An abstract is provided for each section of the chapter, stressing the theme or concepts it explores. Then, for each section, the background required from earlier sections is listed. As already mentioned, this background is kept to a minimum.

At the end of each section, there are four features designed to help you consolidate what you have learned: the Summary, Glossary Words, Exercises, and Suggestions for Further Reading. First, the Summary presents an overview of the material covered in the section. Second, the Glossary Words lists all of the important new words introduced in the section. This list also repeats some of the key words from earlier sections that you should have firmly in mind. The definitions of all these words appear in the glossary at the back of the book. Here, for example, are the glossary entries for the concepts introduced in this section:

**Cybernetics:** *Cybernetics* is the study of computation, communication, and control in the animal and the machine. It has also been extended to the study of information processing in social systems in which humans may interact with machines.

**Cybernetic Society:** A *cybernetic society* is one in which people and machines interact in processing large amounts of information.

**Data Bank:** A *data bank* comprises one or more data bases, together with the computing machinery required to store or use them.

Whenever a word is printed in **boldface**, its definition is given in the glossary at the end of the book, while the word itself appears in the list of glossary words at the end of the section. If you come upon a word that is new to you and is not in boldface, this means one of two things: Either the word has been introduced in an earlier section—in which case it will be in the glossary—or it has not been defined. Because of the technical nature of the subject matter and space limitations, many words have not been included in the glossary. If you find a word that is not in the glossary, look it up in your dictionary and add the definition. Also add the word to the list of glossary words in the section in which it appeared.

The list of glossary words at the end of each section is followed by the Exercises. While they are primarily designed to help you test your understanding of the material in the section, these questions introduce some new

ideas, as well. Even if they have not been given as a class assignment, it is a good idea to read through all the exercises and try to solve a few of them. This will help you remember what you have read and will also indicate to you whether or not you have fully grasped the material. Each section closes with the Suggestions for Further Reading. These annotated lists consist of books and articles to which you can turn for more information. Of course, you can also go to the library to find additional books and magazines.

I hope that the above features make it easy for you to find the sections that interest you and to tie together what you have learned from each section. Most of all, I hope that you find this book stimulating and helpful.

# CONTENTS

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## **1 SOCIAL ISSUES IN THE CYBERNETIC SOCIETY 1**

Introduction	1
The Computer Revolution	2
The Design of Social Systems in a Free Society	4
Networks in National and International Politics	5
Public-Information Networks	9
Summary	12
Glossary Words	13
Exercises	13
Suggestions for Further Reading	13

## **2 ABOUT COMPUTERS AND PROGRAMS 17**

<b>2.1 The Idea of a Program</b>	<b>18</b>
Programming a Simple Robot	18
Programs in Perspective	24
A Digital Wristwatch	26
Bugs and Learning	30
A Walk through the Computer Center	33
Summary	47
Glossary Words	47
Exercises	48
Suggestions for Further Reading	51
<b>2.2 Moving and Storing Information</b>	<b>51</b>
The Shape of a Computer System	51
Coding	59
Payroll Job	62
Summary	68
Glossary Words	68
Exercises	69
Suggestions for Further Reading	71

### **2.3 Translators, Operating Systems, and Time-Sharing 71**

- Translators 71
- Operating Systems 76
- Time-Sharing 80
- Summary 82
- Glossary Words 83
- Exercises 83
- Suggestions for Further Reading 85

## **3 ADVANCES IN COMPUTER TECHNOLOGY 86**

### **3.1 Graphics and Networks 87**

- Computer Graphics 87
- The Squiral Nebula 92
- Computer Networks 96
- Computer Conferencing 101
- Summary 105
- Glossary Words 106
- Exercises 106
- Suggestions for Further Reading 107

### **3.2 The Shrinking Machine and Personal Computers 108**

- Hardware Trends and Microcomputers 109
- New Uses for Microcomputers 111
- The Shrinking Machine 113
- Summary 119
- Glossary Words 120
- Exercises 120
- Suggestions for Further Reading 121

### **3.3 Writing and Rewriting Large Programs 123**

- Large Programs 123
- Top-Down Design 124
- Programming Teams 129
- Program Validation 130
- Rewriting 132
- Summary 133
- Glossary Words 134
- Exercises 134
- Suggestions for Further Reading 135

## **4 THE RISE OF THE DATA BANK 136**

### **4.1 Data-Base Management 136**

A Data Base for Airline Reservations 137

The Problem of Security 144

Summary 149

Glossary Words 150

Exercises 150

Suggestions for Further Reading 151

### **4.2 Computers, Cash, and Crime 151**

The Checkless Society 152

A Sampler of Computer Crimes 156

Summary 161

Glossary Words 162

Exercises 162

Suggestions for Further Reading 163

### **4.3 Data Banks and Privacy 164**

The Need to Control Data Banks 165

The Privacy Act of 1974 167

Implications and Developments 172

Summary 174

Glossary Words 174

Exercises 174

Suggestions for Further Reading 176

## **5 ARTIFICIAL AND NATURAL INTELLIGENCE 178**

### **5.1 Brains, Minds, and Computers 179**

An Overview of the Brain 179

Cooperative Computation 184

Control of Movement 184

Sight 187

Brain Technology 190

Mind and Mechanism 192

Summary 196

Glossary Words 196

Exercises 196

Suggestions for Further Reading 197

**5.2 Robotics and Planning 199**

- Scene Analysis 203
- Planning 206
- Recursion 211
- Summary 215
- Glossary Words 216
- Exercises 216
- Suggestions for Further Reading 218

**5.3 Natural Language Understanding and Expert Systems 219**

- Syntax and Semantics 220
- Talking about the Blocks World 222
- Speech Understanding 226
- Expert Systems 230
- Summary 236
- Glossary Words 237
- Exercises 237
- Suggestions for Further Reading 238

**6 SIMULATING COMPLEX SYSTEMS 240**

**6.1 The Idea of Simulation 241**

- The State of a System 243
- Negative Feedback 249
- Summary 253
- Glossary Words 253
- Exercises 253
- Suggestions for Further Reading 256

**6.2 Prey and Predators 256**

- Isolated Species 257
- Putting the Species Together 263
- Solving the Problem 266
- Summary 268
- Glossary Words 269
- Exercises 269
- Suggestions for Further Reading 270

**6.3 Management Simulation 271**

- Fundamentals of Systems Dynamics 277



The Compound-Interest Model	279
The Inventory Management Model	281
Summary	284
Glossary Words	284
Exercises	284
Suggestions for Further Reading	286

<b>6.4 World Simulation</b>	286
Garbage In/Garbage Out	287
The Limits to Growth	290
A Regional Approach to Global Planning	293
The Danger of Despair	297
Summary	300
Glossary Words	301
Exercises	301
Suggestions for Further Reading	302

## **7 LEARNING AND WORKING** 304

<b>7.1 Computers in Education</b>	305
Drill and Practice CAI	306
Tutorial CAI	310
Dialog-Inquiry CAI	315
The Computer as an Aid to Discovery	318
Summary	321
Glossary Words	322
Exercises	322
Suggestions for Further Reading	323
<b>7.2 Information Flow in the Cybernetic Society</b>	324
Making the News Responsive	325
Computers and Communication	328
The Computerized Library	330
Summary	334
Glossary Words	334
Exercises	334
Suggestions for Further Reading	336
<b>7.3 Automation in Industry and the Office</b>	337
The Industrial Revolution	338
From Assembly Line to Automation	340

Automation and the Unions	343
Cars and Computers	345
Office Automation	348
Summary	353
Glossary Words	353
Exercises	354
Suggestions for Further Reading	355

## **8 NETWORKS AND POLITICS 358**

<b>8.1 Networks for Planning</b>	359
The Idea of a Planning Network	359
Networks for Local Planning	363
Networks for Distributed Planning	365
Summary	370
Glossary Words	371
Exercises	371
Suggestions for Further Reading	372
<b>8.2 Democracy in the Computer Age</b>	373
What Is Democracy?	373
Decisions Take Time and Knowledge	375
Information Networks	379
Summary	383
Glossary Words	384
Exercises	384
Suggestions for Further Reading	385
<b>8.3 Computers in War and Peace</b>	387
Guided Missiles	387
Sensor Arrays	390
Some Moral Issues	392
Summary	394
Glossary Words	394
Exercises	394
Suggestions for Further Reading	396
<b>8.4 A Brain for Planet Earth</b>	398
Grand Aims and Realistic Subgoals	398
The Diversity of Nation-States	403
From Regional Simulations to Global Networks	406

Summary	411
Glossary Words	411
Exercises	411
Suggestions for Further Reading	413

## **9 DOWN AND UP FROM MACHINE LANGUAGE 415**

<b>9.1 How Hardware Works</b>	415
Instructions and Data in Memory	415
An Instruction Set	419
Getting Information in and out of Memory	422
How the Computer Follows a Program	427
The FETCH Cycle for $\langle 109 \rangle = \text{ADD } 37$	428
The EXECUTE Cycle for $\text{ADD } 37$	429
The FETCH Cycle for $\langle 110 \rangle = \text{JMP } 114$	432
The EXECUTE Cycle for $\text{JMP } 114$	433
Summary	433
Glossary Words	434
Exercises	434
Suggestions for Further Reading	436

<b>9.2 Programming and Compiling</b>	436
Adding 100 Numbers	436
Compiling	442
Summary	450
Glossary Words	450
Exercises	450
Suggestions for Further Reading	452

<b>GLOSSARY</b>	453
-----------------	-----

<b>NAME INDEX</b>	479
-------------------	-----

<b>SUBJECT INDEX</b>	483
----------------------	-----