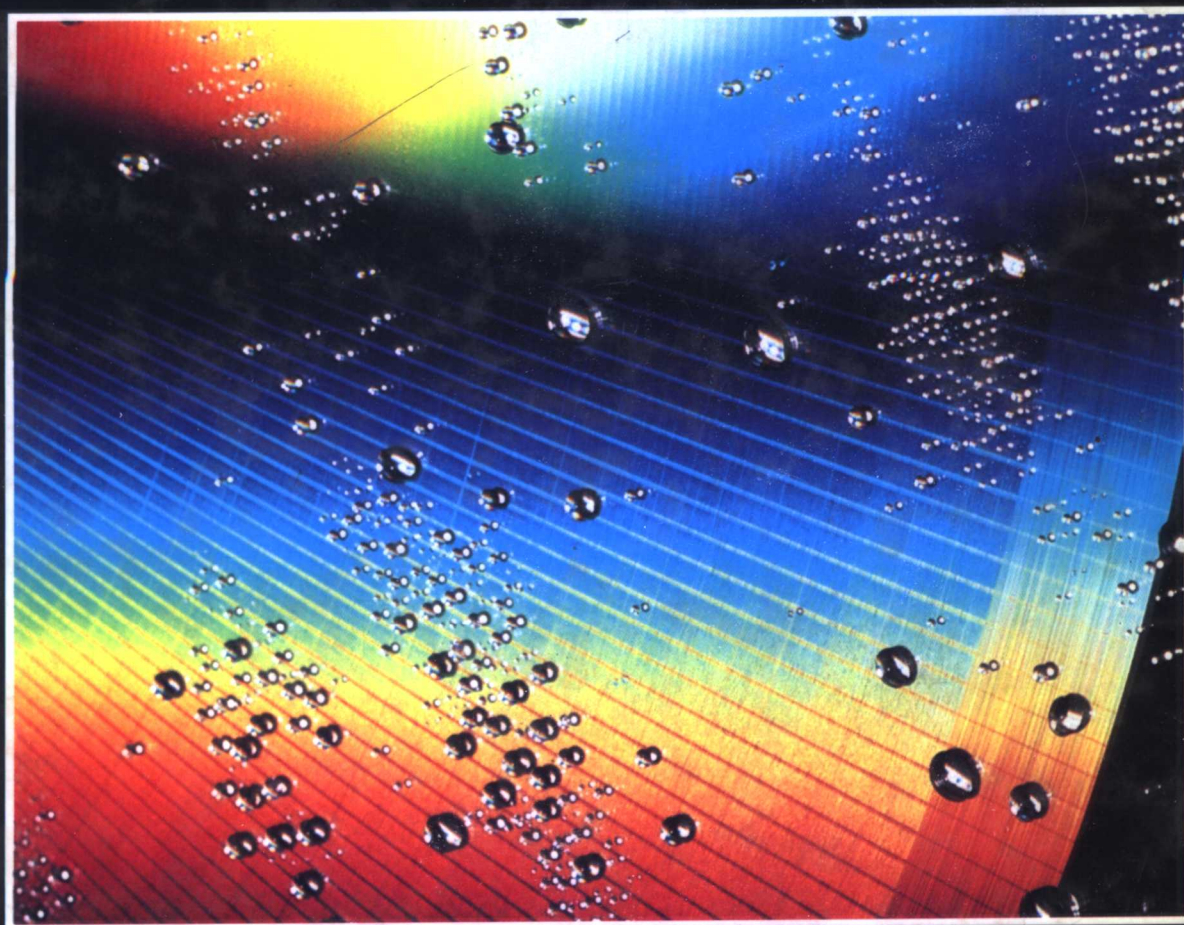


--- The --- **MIND TOOL**

Computers and Their Impact on Society

Fourth Edition

Neill Graham



Language-Free Edition

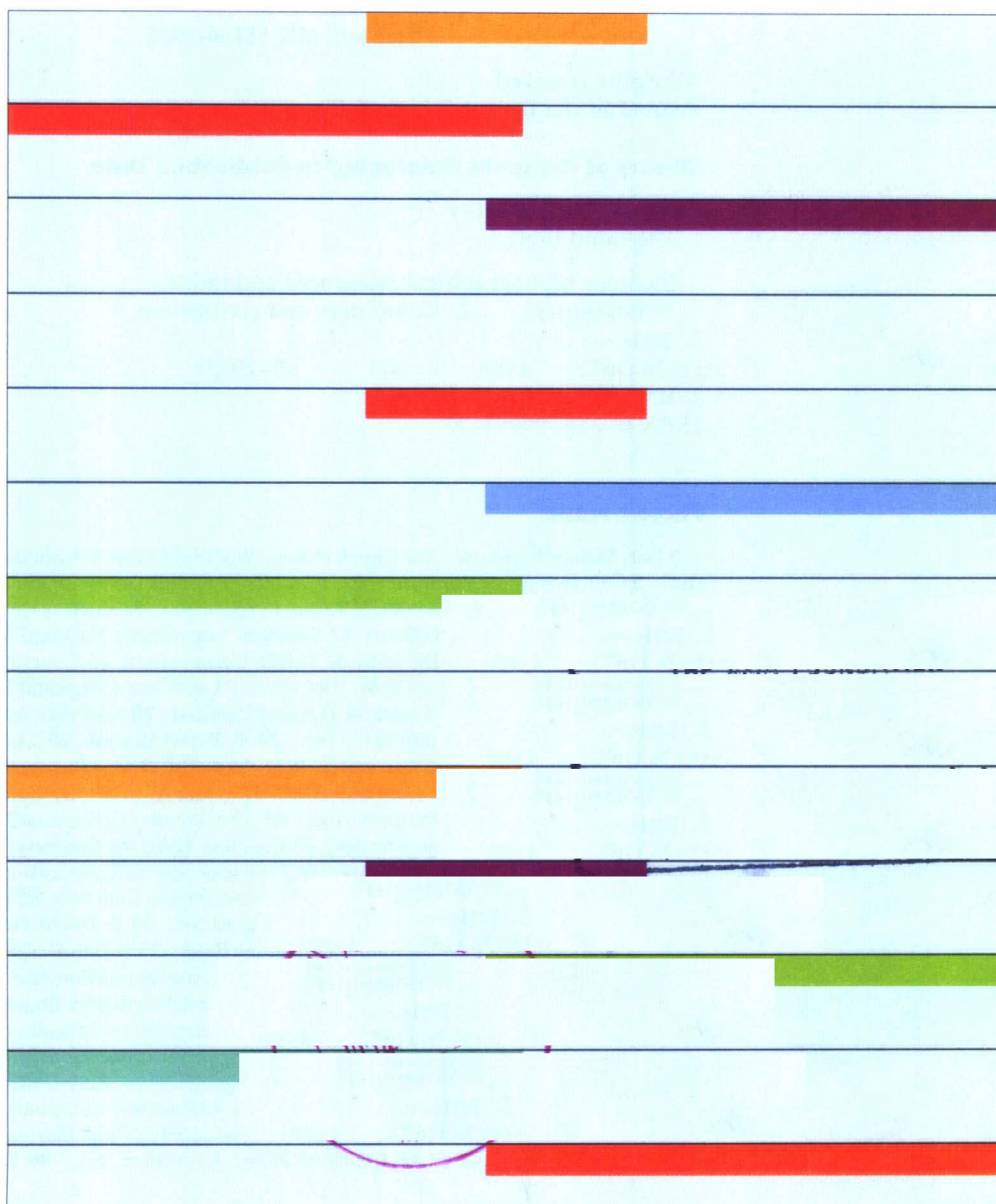
FOURTH EDITION

The Mind Tool

Computers and Their Impact on Society

Language-Free Edition

NEILL GRAHAM



West Publishing Company

ST. PAUL NEW YORK LOS ANGELES SAN FRANCISCO

Copyediting: Chris Thillen
Design: Janet Bollow
Photo Research: Monica Suder
Illustrations: Barbara Barnett
Composition: Parkwood Composition Service, Inc.
Cover Design: Delor Erickson
Cover Photograph: © Joel Gordon 1984

COPYRIGHT © 1976, 1980, 1983 by WEST PUBLISHING COMPANY
COPYRIGHT © 1986 By WEST PUBLISHING COMPANY
50 West Kellogg Boulevard
P.O. Box 64526
St. Paul, MN 55164-1003

All rights reserved
Printed in the United States of America

Library of Congress Cataloging-in-Publication Data

Graham, Neill, 1941–
The mind tool.

Includes bibliographical references and index.

1. Computers. 2. Computers and civilization.

I. Title.

QA76.G672 1986 004 85–20335

ISBN 0–314–93182–1

ISBN 0–314–99081–X

PREFACE

The Mind Tool has been completely rewritten for the fourth edition, and a distinct shift in emphasis will be noticed. Earlier editions were written from the viewpoint of the outsider looking in—of the average citizen who would probably not actually use computers but was interested in their capabilities, limitations, and (above all) their impact on society. Now, courtesy of the microcomputer revolution, this average citizen has a good chance of being more directly involved with computers—if not actually operating them, then purchasing them, managing people who use them, or depending on the results they produce.

This edition of *The Mind Tool* is aimed at those who, in their careers or personal endeavors, are likely to be directly involved with computers. These people need to know enough terminology of the computer field to converse intelligently with computer salespeople and to make sense of hardware and software advertisements. They need to know what a modem does, what a spreadsheet program is good for, why so much software doesn't work as advertised, and what the issues are in the copy protection controversy.

Part One, Overview, is just that. Chapter 1 surveys the basic concepts of the computer field. Chapter 2 provides a brief history of computing and introduces additional concepts. Most of the concepts introduced in Part One are elaborated on later in the book.

Part Two, Computer Systems, is devoted to hardware and software. In this part, more than in any other, instructors will wish to consider carefully which topics they wish to cover, since some sections may cover more technical details than is desirable for some classes. Chapter 3 covers information representation (binary codes) and information storage (main memory, tape, and disks). Chapter 4 discusses the central processing unit and the overall organization of a computer system. Chapter 5 completes the coverage of hardware with a discussion of input and output devices. Chapter 6 covers the most widely used system software, operating systems, and programming languages, and Chapter 7 introduces the student to the art and craft of computer programming.

Part Three, Popular Microcomputer Applications (new in this edition), covers the four most popular microcomputer applications: word processing, electronic spreadsheets, database management, and data communications. Emphasis is on the general capabilities of microcomputers in each application rather than on the specific details of particular hardware and software.

Part Four, Putting Computers To Work, surveys the use of computers in many areas of human endeavor. In contrast to previous editions, which tried (and failed) to cover all important application areas, this edition restricts itself to the following major ones: health care, education, the arts, industry, business and finance, and artificial intelligence. The last of these is not so much an application area as a different approach to using computers, one that promises to become more and more important as time goes on.

Part Five, Computers and Society, covers the impact of computers on society. In contrast to previous editions, societal issues are discussed separately rather than being combined with discussions of computer applications. Topics covered are privacy, computer crime, software piracy, and the effect of computers on employment.

A glossary has been included to help readers cope with the greater number of technical terms required by the more detailed coverage of this edition.

I wish to thank the following persons who commented on the third edition and made suggestions for the fourth edition: Sharon Burrowes, Richard Daughenbaugh, Harry K. Edwards, Lorinda Hite, and Kathleen Korb.

CONTENTS

Preface xv

CHAPTER 1

PART ONE

Computer Concepts 3

Overview 1

Introduction 4

Background 5

Data and Programs 6

Information Storage and Processing 6

Programs and Programming 8

Hardware 10

The Central Processing Unit 10

Main Memory 10

Auxiliary Memory 10

Input and Output 11

Data Communication 11

Classification of Computers 12

Computer Systems 13

Software 14

The Operating System 14

Programming Languages 17

Applications Software 18

Using Computers 18

Scientific, Engineering, and Industrial Applications 19

Business and Financial Data Processing 19

Computers in the Office 20

Computers in Education 22

Home Computers 23

Impact on Society 24

Privacy 25

Computer Crime 25

Employment 26

Human Factors in Computer Use 26

Summary 27

CHAPTER 2

Development of Computers 33

Introduction 34

In the Beginning 34

The Abacus 35

Mechanical Calculators 36

The Slide Rule and Analog Computers	37
The Jacquard Loom	37
The Analytical Engine	38
Charles Babbage	38
The Difference Engine	39
The Analytical Engine	40
Lady Lovelace	41
Boolean Algebra	41
Automatic Data Processing	42
Babbage's Dream Come True	43
Electromechanical Computers	43
Electronic Computers: The Quest for Speed	44
The Stored Program Computer	46
Commercial Manufacture of Computers	47
The Computer Generations	48
The First Generation	48
The Second Generation	49
The Third Generation	50
The Fourth Generation	52
The Fifth Generation	54
Summary	55

PART TWO

CHAPTER 3

Computer Systems 59**Information Representation and Storage 61**

Introduction	62
Binary Codes	62
Information Representation	62
Representing Alternatives	62
The ASCII Code	67
Binary Notation	68
Bits and Bytes	71
Main Memory	72
Main Memory Organization	73
RAM and ROM	74
Auxiliary Memory	76
Magnetic Tape	77
Magnetic Disks	77
Magnetic Bubbles	83
Optical Disks	83
Summary	84

CHAPTER 4

System Organization and the Central Processing Unit 87

Introduction	88
System Organization	88
Physical Organization	91

Central Processing Unit	95
The Arithmetic/Logic Unit	96
Arithmetical Operations	96
Conditions, Flags, and Comparisons	99
Logical Operations	101
Shifting Operations	103
The Control Unit	104
The Fetch-Execute Cycle	104
Jump Instructions	105
Subroutines	107
Interrupts	111
Summary	112

CHAPTER 5

Input and Output Devices 115

Introduction	116
Displays	116
Scanning	116
Memory-Mapped Displays	117
Graphics Displays	118
Text Displays	119
Keyboards	120
Computer Terminals	122
Pointing Devices	123
Punch Card Equipment	126
Optical Character Readers	126
Printers	127
Plotters	129
Speech Synthesizers	129
Speech Recognition	130
Summary	131

CHAPTER 6

Programming Languages and Operating Systems 135

Introduction	136
Programming Languages	136
Machine Language	136
Assembly Language	138
Higher-Level Languages	139
Language Processors	141
The Operating System	142
Functions of the Operating System	142
Concurrent Execution	149
Summary	154

CHAPTER 7**Program Design, Coding, and Testing 157**

- Introduction 158
- Characteristics of Good Software 158
 - Reliability 159
 - Testability 159
 - Usability 160
 - Efficiency 160
 - Portability 161
 - Maintainability 161
- The Software Development Life Cycle 161
 - Requirements Analysis 162
 - Specification 163
 - Design 163
 - Coding 163
 - Testing 164
 - Maintenance 164
- Structured Programming 165
 - Modularity 165
 - The Top-Down Approach 166
 - Control Structures 169
 - Structured Walkthroughs 174
- New Directions in Software Development 175
 - Formal Specifications 175
 - Program Verification 176
 - Program Synthesis 177
- Summary 178

PART THREE**Popular Microcomputer
Applications 181****CHAPTER 8****Word Processing 183**

- Introduction 184
- Commands to Word Processors 185
- Text Storage 187
- Text Display 187
- Text Editing 189
 - Text Entry 189
 - Insertion 190
 - Overtyping 190
 - Deletion 193
 - Block Selection 193
 - Block Delete, Move, Copy, and Insert 196
 - Search 196
 - Search and Replace 199
 - Accept, Cancel, and Undo 200

Formatting and Printing	203
Size and Placement of Text Area	204
Justification, Centering, and Hyphenation	205
Headers and Footers	206
Other Features	207
Windows	207
Document Chaining	207
Substitution for Parameters	207
Spelling Checking	208
Footnotes	208
Index Preparation	209
Type Fonts and Typesetting	209
Summary	210

CHAPTER 9

Electronic Spreadsheets 213

Introduction	214
The Spreadsheet and the Window	214
Elementary Operations	216
Commands	217
Labels and Values	217
Formulas	218
Recalculation	220
Circular References	221
Ranges and Functions	222
Saving, Loading, and Printing	225
Editing	226
Editing and Erasing	226
Inserting, Deleting, and Moving	227
Copying	228
Relative and Absolute References	230
Formatting	231
Consolidating Multiple Spreadsheets	235
Templates	236
Advanced Functions	237
Summary	238

CHAPTER 10

Database Management Systems 241

Introduction	242
Fields, Records, Files, and Relations	242
Basic Operations on Relations	244
Using a Database Management Program	245
Creating a File	246
Data Entry	247

Listing a File	248
Printing a Report	250
Operations on Files and Records	252
Sorting and Indexing	256
Multiple Files	259
Programming	259
Summary	260

CHAPTER 11

Data Communications 263

Introduction	264
Wide Area Networks	264
The Telephone Network	264
Modems	265
Synchronous and Asynchronous Communication	270
Asynchronous Communications Protocols	271
Packet-Switched Networks	275
Applications of Wide Area Data Communications	276
Electronic Mail	276
Communication between Personal Computers	277
Communication with Mainframes	277
Bulletin Board Systems	278
Information Utilities	280
Communications Software	282
Terminal Emulation	282
Uploading and Downloading	283
Automatic Dialing and Log-on	283
Automatic Answering	283
Special Purpose Communications Programs	284
Local Area Networks	284
Transmission Media	285
Circuit-Switched Networks	287
Packet-Switched Networks	287
Nodes	290
Summary	291

PART FOUR

Putting Computers to Work 295

CHAPTER 12

Computers in Health Care 297

Introduction	298
Hospital and Medical Office Administration	298
Patient Interviewing and Examinations	299
Information Retrieval and Computer-Aided Diagnosis	301
Imaging Systems	303
Patient Monitoring	306

Applications to Pharmacy	307
Medical Research	309
Training of Medical Students	310
Genetic Engineering	311
Aiding the Handicapped	312
Standardized Medical Records	313
Summary	315

CHAPTER 13

Computers in Education 319

Introduction	320
Drill and Practice	322
Tutorials	323
Simulation	326
Computer Games	328
Computer Literacy	329
Teaching Programming	331
Computer-Managed Instruction	333
New Directions: Hypertext and LOGO	333
Hypertext	333
LOGO	334
The Outlook for CAI	336
Cost	336
Will the Computer "Depersonalize" Students?	337
Teacher Resistance	337
Instructional Software	338
Summary	338

CHAPTER 14

Computers in Arts and Entertainment 341

Introduction	342
Computer Graphics	342
Graphics Hardware	343
Three-Dimensional Models	345
Animation	346
Perspective, Hidden Lines and Surfaces, and Illumination	348
Textures	349
Fractals	350
Nebulous Phenomena	351
Aliasing	352
Other Applications to Motion Pictures and Television	353
Film Editing	353
Special Effects	355
Production Planning	356
Digital Video	357

Electronic Music	358
Keyboard Synthesizers	359
Digital Sampling	360
Drum Machines	360
The MIDI Connection	361
Sequencers	362
Microcomputer Music Programs	362
Computer Composition	363
Computer Poetry and Fiction	363
Interactive Fiction	364
Literary Research	365
Dance Notation	365
Summary	366

CHAPTER 15

Computers in Industry 371

Introduction	372
Computer-Aided Design	372
Drafting	372
Analysis, Simulation, and Testing	374
Applications to Electronics	375
Computer-Aided Manufacturing	376
Numerically Controlled Machines	376
Robots	377
Flexible Factories	381
Planning and Control	385
Summary	385

CHAPTER 16

Computers in Business and Finance 389

Introduction	390
Management Information Systems	390
Transaction Processing, Bookkeeping, and Accounting	391
Management Reports	395
Decision Support Systems	396
Office Automation	398
Word Processing	398
Electronic Mail	399
Personal Computers	399
Office Information Systems	400
Ergonomics	401
Point-of-Sale Equipment	404
Electronic Funds Transfer	405
Electronic Checks	405
Preauthorized Payments and Deposits	406

Teller Terminals	407
Automatic Teller Machines	408
POS Terminals	409
Possible Pitfalls	409
EFT Legislation	410
Summary	411

CHAPTER 17

Artificial Intelligence 415

Introduction	416
Applications of Artificial Intelligence	418
Problem Solving	418
Natural-Language Processing	419
Perception and Pattern Recognition	420
Automatic Programming	421
Game Playing	421
Logical Reasoning	422
Techniques of Artificial Intelligence	423
Search	423
Heuristic Search	423
Pattern Recognition	424
Planning	426
Representation of Knowledge	426
Programs Using Artificial Intelligence Techniques	427
Chess-Playing Programs	427
Natural-Language Understanding	428
Analyzing Mass Spectrograms	428
Expert Systems	429
Medical Diagnosis	432
Summary	432

CHAPTER 18

Privacy 437

Introduction	438
Data Banks	439
Government Data Banks	439
Private Data Banks	440
Law Enforcement Records	440
Medical Data Banks	441
Record Matching	441
Universal Identifiers	442
Mailing Lists	443
Privacy Legislation	444
The Freedom of Information Act of 1966	444
The Fair Credit Reporting Act of 1970	444

PART FIVE

Computers and Society 435

The Education Privacy Act of 1974	445
The Privacy Act of 1974	445
The Tax Reform Act of 1976	446
The Right to Financial Privacy Act of 1978	446
Summary	446

CHAPTER 19

Computer Crime 451

Introduction	452
Theft and Embezzlement	452
Pacific Telephone	452
Security Pacific	453
Wells Fargo	453
Equity Funding	454
The Gambling Teller	455
Unauthorized Access	455
Software Piracy	457
Computer Security	459
Positive Identification of Users	459
Access Controls	461
Secure Software	462
Data Encryption	463
Backup Copies	463
Summary	463

CHAPTER 20

Computers and Employment 467

Introduction	468
The Impact of Computers on Employment	469
Stopgap Measures	471
Changes in Population Makeup	471
Reducing the Workweek	472
Increased Investment	473
Public Assistance	473
The Japanese Approach	473
Taxes on Automated Equipment	474
Restrictions on Automation	474
Distribution of Income	474
Return to Eden	478
Summary	480
Glossary	G-1
Index	I-1

PART ONE

Overview



