

6th edition

ETHICS

for the information age


MICHAEL J. QUINN

 6th edition

ETHICS

for the information age

This page intentionally left blank



6th edition

ETHICS

for the information age

MICHAEL J. QUINN
Seattle University

PEARSON

Boston Columbus Indianapolis New York San Francisco Upper Saddle River
Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montreal Toronto
Delhi Mexico City Sao Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo

Editorial Director, ECS Marcia Horton
Acquisitions Editor Matt Goldstein
Program Manager Kayla Smith-Tarbox
Director of Marketing Christy Lesko
Marketing Manager Yezan Alayan
Marketing Assistant Jon Bryant
Director of Production Erin Gregg
Senior Managing Editor Scott Disanno
Senior Project Manager Marilyn Lloyd
Manufacturing Buyer Linda Sager
Cover Designer Joyce Cosentino Wells
Text Designer Sandra Rigney
Manager, Text Permissions Tim Nicholls
Text Permission Project Manager William Opaluch
Cover Image © iStock/Getty images
Media Project Manager Renata Butera
Full-Service Project Management Cypress Graphics, Paul C. Anagnostopoulos
Printer/Binder R. R. Donnelley/Harrisonburg
Text Fonts Minion and Nofret

Credits and acknowledgments borrowed from other sources and reproduced, with permission, appear on the appropriate page in the text.

Copyright © 2015, 2013, 2011 Pearson Education, Inc., publishing as Addison-Wesley. All rights reserved. Printed in the United States of America. This publication is protected by Copyright, and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. To obtain permission(s) to use material from this work, please submit a written request to Pearson Education, Inc., Permissions Department, One Lake Street, Upper Saddle River, New Jersey 07458, or you may fax your request to 201-236-3290.

Many of the designations by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and the publisher was aware of a trademark claim, the designations have been printed in initial caps or all caps.

Library of Congress Cataloging-in-Publication Data

Quinn, Michael J.

Ethics for the information age / Michael J. Quinn, Seattle University. — Sixth edition.

pages cm

Includes bibliographical references and index.

ISBN-13: 978-0-13-374162-9 (alk. paper)

ISBN-10: 0-13-374162-1 (alk. paper)

1. Electronic data processing—Moral and ethical aspects. 2. Computers and civilization.

I. Title.

QA76.9.M65Q56 2014

303.48'34—dc23

2013049611

18 17 16 15 14—RRD—10 9 8 7 6 5 4 3 2 1

PEARSON

ISBN 10: 0-13-374162-1

ISBN 13: 978-0-13-374162-9

Brief Contents

Preface xxi

- 1 Catalysts for Change** 1
An Interview with Dalton Conley 47
- 2 Introduction to Ethics** 49
An Interview with James Moor 105
- 3 Networked Communications** 109
An Interview with Michael Liebhold 159
- 4 Intellectual Property** 161
An Interview with June Besek 223
- 5 Information Privacy** 227
An Interview with Michael Zimmer 265
- 6 Privacy and the Government** 269
An Interview with Jerry Berman 315
- 7 Computer and Network Security** 319
An Interview with Matt Bishop 357
- 8 Computer Reliability** 361
An Interview with Avi Rubin 405
- 9 Professional Ethics** 407
An Interview with Paul Axtell 447
- 10 Work and Wealth** 451
An Interview with Martin Ford 491
- Appendix A: Plagiarism** 495

Index 499

This page intentionally left blank

Contents

Preface xxi

1 Catalysts for Change 1

- 1.1 Introduction 2
- 1.2 Milestones in Computing 5
 - 1.2.1 Aids to Manual Calculating 5
 - 1.2.2 Mechanical Calculators 6
 - 1.2.3 Cash Register 8
 - 1.2.4 Punched-Card Tabulation 9
 - 1.2.5 Precursors of Commercial Computers 11
 - 1.2.6 First Commercial Computers 13
 - 1.2.7 Programming Languages and Time-Sharing 14
 - 1.2.8 Transistor and Integrated Circuit 15
 - 1.2.9 IBM System/360 17
 - 1.2.10 Microprocessor 17
 - 1.2.11 Personal Computer 18
- 1.3 Milestones in Networking 21
 - 1.3.1 Electricity and Electromagnetism 21
 - 1.3.2 Telegraph 23
 - 1.3.3 Telephone 24
 - 1.3.4 Typewriter and Teletype 25
 - 1.3.5 Radio 25
 - 1.3.6 Television 26
 - 1.3.7 Remote Computing 28
 - 1.3.8 ARPANET 28
 - 1.3.9 Email 29
 - 1.3.10 Internet 29
 - 1.3.11 NSFNET 31
 - 1.3.12 Broadband 31
 - 1.3.13 Wireless Networks 31

1.4	Milestones in Information Storage and Retrieval	32
1.4.1	Greek Alphabet	32
1.4.2	Codex and Paper	32
1.4.3	Gutenberg's Printing Press	33
1.4.4	Newspapers	33
1.4.5	Hypertext	33
1.4.6	Graphical User Interface	34
1.4.7	Single-Computer Hypertext Systems	36
1.4.8	Networked Hypertext: World Wide Web	36
1.4.9	Search Engines	37
1.5	Information Technology Issues	38
	Summary	39
	Review Questions	41
	Discussion Questions	42
	In-Class Exercises	43
	Further Reading and Viewing	44
	References	44

An Interview with **Dalton Conley** 47

2 **Introduction to Ethics** 49

2.1	Introduction	49
2.1.1	Defining Terms	50
2.1.2	Four Scenarios	52
2.1.3	Overview of Ethical Theories	55
2.2	Subjective Relativism	56
2.2.1	The Case for Subjective Relativism	56
2.2.2	The Case against Subjective Relativism	57
2.3	Cultural Relativism	58
2.3.1	The Case for Cultural Relativism	59
2.3.2	The Case against Cultural Relativism	60
2.4	Divine Command Theory	62
2.4.1	The Case for the Divine Command Theory	62
2.4.2	The Case against the Divine Command Theory	63
2.5	Ethical Egoism	65
2.5.1	The Case for Ethical Egoism	65
2.5.2	The Case against Ethical Egoism	66
2.6	Kantianism	67
2.6.1	Good Will and the Categorical Imperative	68
2.6.2	Evaluating a Scenario Using Kantianism	70

2.6.3	The Case for Kantianism	71
2.6.4	The Case against Kantianism	71
2.7	Act Utilitarianism	72
2.7.1	Principle of Utility	73
2.7.2	Evaluating a Scenario Using Act Utilitarianism	74
2.7.3	The Case for Act Utilitarianism	75
2.7.4	The Case against Act Utilitarianism	76
2.8	Rule Utilitarianism	78
2.8.1	Basis of Rule Utilitarianism	78
2.8.2	Evaluating a Scenario Using Rule Utilitarianism	78
2.8.3	The Case for Rule Utilitarianism	79
2.8.4	The Case against Utilitarianism in General	80
2.9	Social Contract Theory	81
2.9.1	The Social Contract	81
2.9.2	Rawls's Theory of Justice	83
2.9.3	Evaluating a Scenario Using Social Contract Theory	85
2.9.4	The Case for Social Contract Theory	86
2.9.5	The Case against Social Contract Theory	87
2.10	Virtue Ethics	89
2.10.1	Virtues and Vices	89
2.10.2	Making a Decision Using Virtue Ethics	91
2.10.3	The Case for Virtue Ethics	92
2.10.4	The Case against Virtue Ethics	93
2.11	Comparing Workable Ethical Theories	94
2.12	Morality of Breaking the Law	96
2.12.1	Social Contract Theory Perspective	96
2.12.2	Kantian Perspective	96
2.12.3	Rule Utilitarian Perspective	97
2.12.4	Act Utilitarian Perspective	97
2.12.5	Conclusion	98
	Summary	98
	Review Questions	99
	Discussion Questions	101
	In-Class Exercises	102
	Further Reading and Viewing	103
	References	103

An Interview with James Moor	105
-------------------------------------	-----

3	Networked Communications	109
3.1	Introduction	109
3.2	Spam	111
3.2.1	The Spam Epidemic	112
3.2.2	Need for Social-Technical Solutions	113
3.2.3	Case Study: Ann the Acme Accountant	114
3.3	Internet Interactions	117
3.3.1	The World Wide Web	117
3.3.2	The Rise of the App	117
3.3.3	How We Use the Internet	117
3.4	Text Messaging	120
3.4.1	Transforming Lives in Developing Countries	120
3.4.2	Twitter	121
3.4.3	Business Promotion	121
3.4.4	Political Activism	121
3.5	Censorship	122
3.5.1	Direct Censorship	122
3.5.2	Self-Censorship	123
3.5.3	Challenges Posed by the Internet	124
3.5.4	Government Filtering and Surveillance of Internet Content	124
3.5.5	Ethical Perspectives on Censorship	125
3.6	Freedom of Expression	127
3.6.1	History	127
3.6.2	Freedom of Expression Not an Absolute Right	128
3.6.3	<i>FCC v. Pacifica Foundation</i>	129
3.6.4	Case Study: Kate's Blog	130
3.7	Children and Inappropriate Content	132
3.7.1	Web Filters	132
3.7.2	Child Internet Protection Act	133
3.7.3	Ethical Evaluations of CIPA	134
3.7.4	Sexting	135
3.8	Breaking Trust	137
3.8.1	Identity Theft	137
3.8.2	Chat-Room Predators	138
3.8.3	Ethical Evaluations of Police Sting Operations	139
3.8.4	False Information	141
3.8.5	Cyberbullying	142
3.9	Internet Addiction	143
3.9.1	Is Internet Addiction Real?	143
3.9.2	Contributing Factors	145

3.9.3 Ethical Evaluation of Internet Addiction	146
Summary	147
Review Questions	148
Discussion Questions	149
In-Class Exercises	151
Further Reading and Viewing	152
References	153

An Interview with **Michael Liebhold** 159

4 Intellectual Property 161

4.1 Introduction	161
4.2 Intellectual Property Rights	163
4.2.1 Property Rights	163
4.2.2 Extending the Argument to Intellectual Property	164
4.2.3 Benefits of Intellectual Property Protection	167
4.2.4 Limits to Intellectual Property Protection	167
4.3 Protecting Intellectual Property	169
4.3.1 Trade Secrets	169
4.3.2 Trademarks and Service Marks	170
4.3.3 Patents	170
4.3.4 Copyrights	172
4.4 Fair Use	176
4.4.1 <i>Sony v. Universal City Studios</i>	177
4.4.2 Digital Recording Technology	179
4.4.3 Audio Home Recording Act of 1992	179
4.4.4 <i>RIAA v. Diamond Multimedia</i>	179
4.4.5 <i>Kelly v. Arriba Soft</i>	180
4.4.6 Google Books	181
4.5 New Restrictions on Use	182
4.5.1 Digital Millennium Copyright Act	183
4.5.2 Digital Rights Management	184
4.5.3 Secure Digital Music Initiative	184
4.5.4 Sony BMG Music Entertainment Rootkit	184
4.5.5 Encrypting DVDs	185
4.5.6 Foiling HD-DVD Encryption	186
4.5.7 Criticisms of Digital Rights Management	186
4.5.8 Online Music Stores Drop Digital Rights Management	187
4.5.9 Microsoft Xbox One	187
4.6 Peer-to-Peer Networks and Cyberlockers	188
4.6.1 Napster	189

- 4.6.2 FastTrack 189
- 4.6.3 BitTorrent 190
- 4.6.4 RIAA Lawsuits 191
- 4.6.5 *MGM v. Grokster* 192
- 4.6.6 Legal Action against the Pirate Bay 194
- 4.6.7 PRO-IP Act 195
- 4.6.8 Megaupload Shutdown 195
- 4.6.9 Legal Music Services on the Internet 195
- 4.7 Protections for Software 196**
 - 4.7.1 Software Copyrights 196
 - 4.7.2 Violations of Software Copyrights 196
 - 4.7.3 Safe Software Development 197
 - 4.7.4 Software Patents 198
- 4.8 Open-Source Software 200**
 - 4.8.1 Consequences of Proprietary Software 200
 - 4.8.2 “Open Source” Definition 201
 - 4.8.3 Beneficial Consequences of Open-Source Software 202
 - 4.8.4 Examples of Open-Source Software 202
 - 4.8.5 The GNU Project and Linux 203
 - 4.8.6 Impact of Open-Source Software 204
 - 4.8.7 Critique of the Open-Source Software Movement 204
- 4.9 Legitimacy of Intellectual Property Protection for Software 205**
 - 4.9.1 Rights-Based Analysis 205
 - 4.9.2 Utilitarian Analysis 206
 - 4.9.3 Conclusion 207
- 4.10 Creative Commons 208**
 - Summary 210
 - Review Questions 213
 - Discussion Questions 214
 - In-Class Exercises 214
 - Further Reading and Viewing 215
 - References 216

An Interview with **June Besek** 223

5 Information Privacy 227

- 5.1 Introduction 227**
- 5.2 Perspectives on Privacy 229**
 - 5.2.1 Defining Privacy 229
 - 5.2.2 Harms and Benefits of Privacy 230
 - 5.2.3 Is There a Natural Right to Privacy? 232

5.2.4	Privacy and Trust	236
5.2.5	Case Study: The New Parents	236
5.3	Information Disclosures	238
5.3.1	Facebook Tags	240
5.3.2	Enhanced 911 Services	240
5.3.3	Rewards or Loyalty Programs	241
5.3.4	Body Scanners	241
5.3.5	RFID Tags	242
5.3.6	Implanted Chips	243
5.3.7	OnStar	244
5.3.8	Automobile “Black Boxes”	244
5.3.9	Medical Records	245
5.3.10	Digital Video Recorders	245
5.3.11	Cookies and Flash Cookies	245
5.4	Data Mining	246
5.4.1	Data Mining Defined	246
5.4.2	Opt-In versus Opt-Out Policies	247
5.4.3	Examples of Data Mining	248
5.4.4	Social Network Analysis	251
5.5	Examples of Consumer Backlash	252
5.5.1	Marketplace: Households	252
5.5.2	Facebook Beacon	253
5.5.3	Netflix Prize	253
5.5.4	Malls Track Shoppers’ Cell Phones	254
5.5.5	iPhone Apps Uploading Address Books	254
5.5.6	Instagram’s Proposed Change to Terms of Service	255
	Summary	255
	Review Questions	256
	Discussion Questions	257
	In-Class Exercises	259
	Further Reading and Viewing	260
	References	261

An Interview with **Michael Zimmer** 265

6 Privacy and the Government 269

6.1	Introduction	269
6.2	US Legislation Restricting Information Collection	271
6.2.1	Employee Polygraph Protection Act	271
6.2.2	Children’s Online Privacy Protection Act	271
6.2.3	Genetic Information Nondiscrimination Act	271

6.3	Information Collection by the Government	272
6.3.1	Census Records	272
6.3.2	Internal Revenue Service Records	273
6.3.3	FBI National Crime Information Center 2000	274
6.3.4	OneDOJ Database	275
6.3.5	Closed-Circuit Television Cameras	276
6.3.6	Police Drones	277
6.4	Covert Government Surveillance	278
6.4.1	Wiretaps and Bugs	278
6.4.2	Operation Shamrock	281
6.4.3	Carnivore Surveillance System	282
6.4.4	Covert Activities after 9/11	282
6.5	US Legislation Authorizing Wiretapping	283
6.5.1	Title III	283
6.5.2	Foreign Intelligence Surveillance Act	284
6.5.3	Electronic Communications Privacy Act	284
6.5.4	Stored Communications Act	285
6.5.5	Communications Assistance for Law Enforcement Act	285
6.6	USA PATRIOT Act	286
6.6.1	Provisions of the Patriot Act	286
6.6.2	National Security Letters	287
6.6.3	Responses to the Patriot Act	288
6.6.4	Successes and Failures	289
6.6.5	Patriot Act Renewal	290
6.6.6	Long-Standing NSA Access to Telephone Records	290
6.7	Regulation of Public and Private Databases	291
6.7.1	Code of Fair Information Practices	291
6.7.2	Privacy Act of 1974	293
6.7.3	Fair Credit Reporting Act	294
6.7.4	Fair and Accurate Credit Transactions Act	294
6.7.5	Financial Services Modernization Act	294
6.8	Data Mining by the Government	295
6.8.1	Internal Revenue Service Audits	295
6.8.2	Syndromic Surveillance Systems	295
6.8.3	Telecommunications Records Database	295
6.8.4	Predictive Policing	296
6.9	National Identification Card	296
6.9.1	History and Role of the Social Security Number	296
6.9.2	Debate over a National ID Card	297
6.9.3	The REAL ID Act	299

6.10	Information Dissemination	300
6.10.1	Family Education Rights and Privacy Act	300
6.10.2	Video Privacy Protection Act	300
6.10.3	Health Insurance Portability and Accountability Act	301
6.10.4	Freedom of Information Act	301
6.10.5	Toll Booth Records Used in Court	302
6.11	Invasion	302
6.11.1	Telemarketing	303
6.11.2	Loud Television Commercials	303
6.11.3	Requiring Identification for Pseudoephedrine Purchases	303
6.11.4	Advanced Imaging Technology Scanners	304
	Summary	305
	Review Questions	306
	Discussion Questions	308
	In-Class Exercises	309
	Further Reading and Viewing	309
	References	309
	An Interview with Jerry Berman	315

7 **Computer and Network Security** 319

7.1	Introduction	319
7.2	Hacking	320
7.2.1	Hackers, Past and Present	320
7.2.2	Penalties for Hacking	321
7.2.3	Selected Hacking Incidents	322
7.2.4	Case Study: Firesheep	323
7.3	Malware	325
7.3.1	Viruses	326
7.3.2	The Internet Worm	328
7.3.3	Sasser	332
7.3.4	Instant Messaging Worms	333
7.3.5	Conficker	333
7.3.6	Cross-Site Scripting	333
7.3.7	Drive-By Downloads	333
7.3.8	Trojan Horses and Backdoor Trojans	334
7.3.9	Rootkits	334
7.3.10	Spyware and Adware	334
7.3.11	Bots and Botnets	334
7.3.12	Defensive Measures	335

7.4	Cyber Crime and Cyber Attacks	335
7.4.1	Phishing and Spear Phishing	336
7.4.2	SQL Injection	336
7.4.3	Denial-of-Service and Distributed Denial-of-Service Attacks	336
7.4.4	Cyber Crime	337
7.4.5	Politically Motivated Cyber Attacks	339
7.5	Online Voting	343
7.5.1	Motivation for Online Voting	343
7.5.2	Proposals	344
7.5.3	Ethical Evaluation	345
	Summary	348
	Review Questions	348
	Discussion Questions	349
	In-Class Exercises	351
	Further Reading and Viewing	352
	References	352
	An Interview with Matt Bishop	357

8 Computer Reliability 361

8.1	Introduction	361
8.2	Data Entry or Data Retrieval Errors	362
8.2.1	Disenfranchised Voters	362
8.2.2	False Arrests	362
8.2.3	Utilitarian Analysis: Accuracy of NCIC Records	363
8.3	Software and Billing Errors	364
8.3.1	Errors Leading to System Malfunctions	364
8.3.2	Errors Leading to System Failures	365
8.3.3	Analysis: E-retailer Posts Wrong Price, Refuses to Deliver	367
8.4	Notable Software System Failures	367
8.4.1	Patriot Missile	368
8.4.2	Ariane 5	369
8.4.3	AT&T Long-Distance Network	370
8.4.4	Robot Missions to Mars	371
8.4.5	Denver International Airport	372
8.4.6	Tokyo Stock Exchange	373
8.4.7	Direct Recording Electronic Voting Machines	374
8.5	Therac-25	377
8.5.1	Genesis of the Therac-25	377
8.5.2	Chronology of Accidents and AECL Responses	378
8.5.3	Software Errors	380
8.5.4	Postmortem	382

8.5.5	Moral Responsibility of the Therac-25 Team	383
8.5.6	Postscript	384
8.6	Computer Simulations	384
8.6.1	Uses of Simulation	384
8.6.2	Validating Simulations	386
8.7	Software Engineering	387
8.7.1	Specification	388
8.7.2	Development	388
8.7.3	Validation	389
8.7.4	Evolution	390
8.7.5	Software Quality Is Improving	390
8.8	Software Warranties and Vendor Liability	391
8.8.1	Shrink-wrap Warranties	391
8.8.2	Are Software Warranties Enforceable?	392
8.8.3	Should Software Be Considered a Product?	395
8.8.4	Case Study: Incredible Bulk	395
	Summary	396
	Review Questions	398
	Discussion Questions	399
	In-Class Exercises	400
	Further Reading and Viewing	401
	References	401

An Interview with **Avi Rubin** 405

9 Professional Ethics 407

9.1	Introduction	407
9.2	How Well Developed Are the Computing Professions?	409
9.2.1	Characteristics of a Fully Developed Profession	409
9.2.2	Case Study: Certified Public Accountants	410
9.2.3	How Do Computer-Related Careers Stack Up?	411
9.3	Software Engineering Code of Ethics	413
9.4	Analysis of the Code	421
9.4.1	Preamble	421
9.4.2	Alternative List of Fundamental Principles	422
9.5	Case Studies	423
9.5.1	Software Recommendation	424
9.5.2	Child Pornography	425
9.5.3	Antiworm	426
9.5.4	Consulting Opportunity	428

9.6 Whistle-Blowing	430
9.6.1 Morton Thiokol/NASA	431
9.6.2 Hughes Aircraft	432
9.6.3 US Legislation Related to Whistle-Blowing	434
9.6.4 Morality of Whistle-Blowing	435
Summary	438
Review Questions	439
Discussion Questions	440
In-Class Exercises	442
Further Reading and Viewing	443
References	443

An Interview with Paul Axtell	447
--------------------------------------	-----

10 Work and Wealth 451

10.1 Introduction	451
10.2 Automation and Employment	452
10.2.1 Automation and Job Destruction	453
10.2.2 Automation and Job Creation	455
10.2.3 Effects of Increase in Productivity	456
10.2.4 Rise of the Robots?	458
10.3 Workplace Changes	461
10.3.1 Organizational Changes	462
10.3.2 Telework	463
10.3.3 Temporary Work	465
10.3.4 Monitoring	465
10.3.5 Multinational Teams	466
10.4 Globalization	468
10.4.1 Arguments for Globalization	468
10.4.2 Arguments against Globalization	469
10.4.3 Dot-Com Bust Increases IT Sector Unemployment	470
10.4.4 Foreign Workers in the American IT Industry	470
10.4.5 Foreign Competition	471
10.5 The Digital Divide	472
10.5.1 Global Divide	473
10.5.2 Social Divide	474
10.5.3 Models of Technological Diffusion	474
10.5.4 Critiques of the Digital Divide	476
10.5.5 Massive Open Online Courses	477
10.5.6 Net Neutrality	478

10.6 The “Winner-Take-All Society”	479
10.6.1 Harmful Effects of Winner-Take-All	480
10.6.2 Reducing Winner-Take-All Effects	482
Summary	482
Review Questions	484
Discussion Questions	484
In-Class Exercises	486
Further Reading and Viewing	487
References	487
An Interview with Martin Ford	491
Appendix A: Plagiarism	495
Consequences of Plagiarism	495
Types of Plagiarism	495
Guidelines for Citing Sources	496
How to Avoid Plagiarism	496
Misuse of Sources	496
Additional Information	497
References	497
Index	499

This page intentionally left blank

Preface

Computers and high-speed communication networks are transforming our world. These technologies have brought us many benefits, but they have also raised many social and ethical concerns. My view is that we ought to approach every new technology in a thoughtful manner, considering not just its short-term benefits, but also how its long-term use will affect our lives. A thoughtful response to information technology requires a basic understanding of its history, an awareness of current information-technology-related issues, and a familiarity with ethics. I have written *Ethics for the Information Age* with these ends in mind.

Ethics for the Information Age is suitable for college students at all levels. The only prerequisite is some experience using computers and the Internet. The book is appropriate for a stand-alone “computers and society” or “computer ethics” course offered by a computer science, business, or philosophy department. It can also be used as a supplemental textbook in a technical course that devotes some time to social and ethical issues related to computing.

As students discuss controversial issues related to information technology, they have the opportunity to learn from one other and improve their critical thinking skills. The provocative questions raised at the end of every chapter, together with dozens of in-class exercises, provide many opportunities for students to express their viewpoints. My hope is that they will get better at evaluating complex issues and defending their conclusions with facts, sound values, and rational arguments.

WHAT’S NEW IN THE SIXTH EDITION

The most significant change in the sixth edition is the new emphasis on virtue ethics. I have written a completely new section on virtue ethics that appears in Chapter 2, replacing the description of virtue ethics that formerly appeared in the chapter on professional ethics. In addition, I have included analyses from the perspective of virtue ethics to the case studies appearing in Chapters 3, 5, and 7.

To increase the relevance and value of the “Further Reading and Viewing” sections, I have eliminated the references to scholarly tomes. They have been replaced by lists of recent magazine and newspaper articles, television interviews, documentaries, and other videos available on the Internet. Most of the videos are only a few minutes long and can fuel interesting classroom discussions.

In response to a suggestion from one of the reviewers, I have added a table to Chapter 7 that provides students with practical tips about how to choose good passwords.

The sixth edition references many important recent developments; among them are:

- Edward Snowden’s revelations of longstanding National Security Agency access to telephone metadata, email messages, and live communications;
- the privacy implications of Twitter, Foursquare, Instagram, and other apps gathering information from address books stored on smartphones;
- the controversy surrounding Microsoft’s proposal for digital rights management on the Xbox One;
- the activities of the “hactivist” group Anonymous;
- benefits and harms of tracking the movement of people through their smartphones;
- the debate over the use of drones by police departments;
- retailers using information collected from online sales to differentiate between customers and offer different prices to different people;
- retailers using targeted direct marketing to win new customers;
- the use of “crowdsourcing” by companies to improve products and services;
- coverage of how cell phones are changing lives in developing countries;
- predictive policing based on data mining;
- massive open online courses (MOOCs) and implications for students from different socio-economic groups; and
- the “Internet of Things”—Internet-connected devices that can be controlled remotely.

Finally, I have updated facts and figures throughout the book.

ORGANIZATION OF THE BOOK

The book is divided into ten chapters. Chapter 1 has three objectives: to get the reader thinking about the process of technological change; to present a brief history of computing, networking, and information storage and retrieval; and to provide examples of moral problems brought about by the introduction of information technology.

Chapter 2 is an introduction to ethics. It presents nine different theories of ethical decision-making, weighing the pros and cons of each one. Five of these theories—Kantianism, act utilitarianism, rule utilitarianism, social contract theory, and virtue ethics—are deemed the most appropriate “tools” for analyzing moral problems in the remaining chapters.

Chapters 3–10 discuss a wide variety of issues related to the introduction of information technology into society. I think of these chapters as forming concentric rings around a particular computer user.

Chapter 3 is the innermost ring, dealing with what can happen when people communicate over the Internet using the Web, email, and Twitter. Issues such as the increase in spam, easy access to pornography, cyberbullying, and Internet addiction raise important questions related to quality of life, free speech, and censorship.

The next ring, Chapter 4, deals with the creation and exchange of intellectual property. It discusses intellectual property rights, legal safeguards for intellectual property, the definition of fair use, digital rights management, abuses of peer-to-peer networks, the rise of the open-source movement, and the legitimacy of intellectual property protection for software.

Chapter 5 focuses on information privacy. What is privacy exactly? Is there a natural right to privacy? How do others learn so much about us? The chapter describes the electronic trail that people leave behind when they use a cell phone, make credit card purchases, open a bank account, go to a physician, or apply for a loan.

Chapter 6 focuses on privacy and the US government. Using Daniel Solove's taxonomy of privacy as our organizing principle, we look at how the government has steered between the competing interests of personal privacy and public safety. We consider US legislation to restrict information collection and government surveillance; government regulation of private databases and abuses of large government databases; legislation to reduce the dissemination of information and legislation that has had the opposite effect; and finally government actions to prevent the invasion of privacy as well as invasive government actions. Along the way, we discuss the implications of the USA PATRIOT Act and the debate over the REAL ID Act to establish a de facto national identification card.

Chapter 7 focuses on the vulnerabilities of networked computers. A case study focuses on the release of the Firesheep extension to the Firefox Web browser. A section on malware discusses rootkits, spyware, cross-site scripting, and drive-by downloads. We discuss common Internet-based attacks—phishing, spear-phishing, SQL injection, denial-of-service attacks, and distributed denial-of-service attacks—and how they are used for cyber crime, cyber espionage, and cyber attacks. We conclude with a discussion of the risks associated with online voting.

Computerized system failures have led to lost business, the destruction of property, human suffering, and even death. Chapter 8 describes some notable software system failures, including the story of the Therac-25 radiation therapy system. It also discusses the reliability of computer simulations, the emergence of software engineering as a distinct discipline, and the validity of software warranties.

Chapter 9 is particularly relevant for those readers who plan to take jobs in the computer industry. The chapter presents a professional code related to computing, the Software Engineering Code of Ethics and Professional Practice, followed by an analysis of the code. Several case studies illustrate how to use the Software Engineering Code of Ethics and Professional Practice to evaluate moral problems related to the use of computers. The chapter concludes with an ethical evaluation of whistle-blowing, an extreme example of organizational dissent.

Chapter 10 raises a wide variety of issues related to how information technology has impacted work and wealth. Topics include workplace monitoring, telecommuting, and globalization. Does automation increase unemployment? Is there a “digital divide” separating society into “haves” and “have nots”? Is information technology widening the gap between rich and poor? These are just a few of the important questions the chapter addresses.

<i>Unit</i>	<i>Name</i>	<i>Chapter(s)</i>
SP1	History of computing	1
SP2	Social context of computing	1, 3, 10
SP3	Methods and tools of analysis	2–10
SP4	Professional and ethical responsibilities	9
SP5	Risks and liabilities of computer-based systems	8
SP6	Intellectual property	4
SP7	Privacy and civil liberties	5, 6
SP8	Computer crime	3, 7
SP9	Economic issues in computing	10
SP10	Philosophical frameworks	2

TABLE 1 Mapping between the units of the Social and Professional Issues course in *Computing Curricula 2001* and the chapters of this book.

NOTE TO INSTRUCTORS

In December 2001, a joint task force of the IEEE Computer Society and the Association for Computing Machinery released the final draft of *Computing Curricula 2001* (www.computer.org/education/cc2001/final). The report recommends that every undergraduate computer science degree program incorporate 40 hours of instruction related to social and professional issues related to computing. For those departments that choose to dedicate an entire course to these issues, the report provides a model syllabus for CS 280T, Social and Professional Issues. *Ethics for the Information Age* covers all of the major topics listed in the syllabus. Table 1 shows the mapping between the 10 units of CS 280T and the chapters of this book.

The organization of the book makes it easy to adapt to your particular needs. If your syllabus does not include the history of information technology, you can skip the middle three sections of Chapter 1 and still expose your students to examples motivating the formal study of ethics in Chapter 2. After Chapter 2, you may cover the remaining chapters in any order you choose, because Chapters 3–10 do not depend on one other.

Many departments choose to incorporate discussions of social and ethical issues throughout the undergraduate curriculum. The independence of Chapters 3–10 makes it convenient to use *Ethics for the Information Age* as a supplementary textbook. You can simply assign readings from the chapters most closely related to the course topic.

SUPPLEMENTS

The following supplements are available to qualified instructors on Pearson's Instructor Resource Center. Please contact your local Pearson sales representative or visit www.pearsonhighered.com/educator to access this material.

- An instructor's manual provides tips for teaching a course in computer ethics. It also contains answers to all of the review questions.

- A test bank contains more than 300 multiple-choice, fill-in-the-blank, and essay questions that you can use for quizzes, midterms, and final examinations.
- A set of PowerPoint lecture slides outlines the material covered in every chapter.

FEEDBACK

Ethics for the Information Age cites hundreds of sources and includes dozens of ethical analyses. Despite my best efforts and those of many reviewers, the book is bound to contain errors. I appreciate getting comments (both positive and negative), corrections, and suggestions from readers. Please send them to quinnm@seattleu.edu or Michael J. Quinn, Seattle University, College of Science and Engineering, 901 12th Avenue, Seattle, WA 98122.

ACKNOWLEDGMENTS

I appreciate the continuing support of a great publications team, beginning with editor Matt Goldstein, and including Kayla Tarbox, Marilyn Lloyd, Kathy Ringrose, Craig Jones, Paul Anagnostopoulos, Jacqui Scarlott, Jennifer McClain, Richard Camp, Laurel Muller, and Ted Laux. I thank them and everyone else who helped produce this edition.

A superb group of reviewers provided me with many helpful suggestions regarding new material to incorporate into the sixth edition. I thank: Donna Maria D'Ambrosio, University of South Florida; Dawit Demissie, The Sage Colleges; J.C. Diaz, The University of Tulsa; Fred Geldon, George Mason University; Richard E. Gordon, University of Delaware; Michael Gourley, University of Central Oklahoma; Robert Greene, University of Wisconsin–Eau Claire; Gurdeep Hura, University of Maryland Eastern Shore; Evelyn Lulis, DePaul University; Aparna Mahadev, Worcester State University; Daniel Palmer, Kent State University; Jason Rogers, George Mason University; and Scott Vitz, Indiana University–Purdue University Fort Wayne.

I am grateful to philosophy professor Maria Carl of Seattle University, who reviewed the new material on virtue ethics and provided me with valuable and constructive feedback.

I thank all who participated in the creation of the first five editions or provided useful suggestions for the sixth edition: Paul Anagnostopoulos, Valerie Anctil, Beth Anderson, Bob Baddeley, George Beekman, Brian Breck, Sherry Clark, Thomas Dieterich, Roger Eastman, Beverly Fusfield, Robert Greene, Peter Harris, Susan Hartman, Michael Hirsch, Michael Johnson, Marilyn Lloyd, Pat McCutcheon, Beth Paquin, Brandon Quinn, Stuart Quinn, Victoria Quinn, Charley Renn, Lindsey Triebel, and Shauna Weaver.

Reviewers of previous editions include: Ramprasad Bala, University of Massachusetts at Dartmouth; Phillip Barry, University of Minnesota; Bo Brinkman, Miami University; Diane Cassidy, The University of North Carolina at Charlotte; Madhavi M. Chakrabarty, New Jersey Institute of Technology; John Clark, University of Colorado at Denver; Timothy Colburn, University of Minnesota–Duluth; Lorrie Faith Cranor, Carnegie Mellon University; Lee D. Cornell, Minnesota State University, Mankato; Richard W. Egan, New Jersey Institute of Technology; David Goodall, State University of New York at Albany; Richard E. Gordon, University of Delaware; Mike Gourley,

University of Central Oklahoma; Fritz H. Grupe, University of Nevada, Reno; Ric Heishman, George Mason University; Paulette Kidder, Seattle University; Evelyn Lulis, DePaul University; Tamara A. Maddox, George Mason University; Eric Manley, Drake University; Richard D. Manning, Nova Southeastern University; John G. Messerly, University of Texas at Austin; Joe Oldham, Centre College; Mimi Opkins, California State University, Long Beach; Holly Patterson-McNeill, Lewis-Clark State College; Colin Potts, Georgia Tech; Medha S. Sarkar, Middle Tennessee State University; Michael Scanlan, Oregon State University; Robert Sloan, University of Illinois at Chicago; Matthew Stockton, Portland Community College; Leon Tabak, Cornell College; Renée Turban, Arizona State University; Scott Vitz, Indiana University–Purdue University Fort Wayne; David Womack, University of Texas at San Antonio; John Wright, Juniata College; and Matthew Zullo, Wake Technical Community College.

Finally, I am indebted to my wife Victoria for her support and encouragement. You are a wonderful helpmate. Thanks for everything.

Michael J. Quinn
Seattle, Washington

We never know how high we are
Till we are called to rise;
And then, if we are true to plan,
Our statures touch the skies.
The heroism we recite
Would be a daily thing,
Did not ourselves the cubits warp
For fear to be a king.

—EMILY DICKINSON, *Aspiration*

I dedicate this book to my children: *Shauna, Brandon, and Courtney*.

Know that my love goes with you, wherever your aspirations may lead you.

This page intentionally left blank

1

Catalysts for Change

A tourist came in from Orbitville,
parked in the air, and said:
The creatures of this star
are made of metal and glass.
Through the transparent parts
you can see their guts.
Their feet are round and roll
on diagrams of long
measuring tapes, dark
with white lines.
They have four eyes.
The two in back are red.
Sometimes you can see a five-eyed
one, with a red eye turning
on the top of his head.
He must be special—
the others respect him
and go slow
when he passes, winding
among them from behind.
They all hiss as they glide,
like inches, down the marked
tapes. Those soft shapes,
shadowy inside
the hard bodies—are they
their guts or their brains?

—MAY SWENSON, "Southbound on the Freeway"¹

1.1 Introduction

MOST OF US TAKE TECHNOLOGICAL CHANGE FOR GRANTED. In the past two decades alone, we have witnessed the emergence of exciting new technologies, including smartphones, MP3 players, digital photography, email, and the World Wide Web. There is good reason to say we are living in the Information Age. Never before have so many people had such easy access to information. The two principal catalysts for the Information Age have been low-cost computers and high-speed communication networks (Figure 1.1). Even in a society accustomed to change, the rate at which computers and communication networks have transformed our lives is breathtaking.

In 1950 there were no more than a handful of electronic digital computers in the world. Today we are surrounded by devices containing embedded computers. We rely upon microprocessors to control our heating and cooling systems, microwaves, smartphones, elevators, and a multitude of other devices we use every day. Thanks to microprocessors, our automobiles get better gas mileage and produce less pollution. On the other hand, the days of the do-it-yourself tune-up are gone. It takes a mechanic with computerized diagnostic equipment to work on a modern engine.



FIGURE 1.1 Low-cost computers and high-speed communication networks make possible the products of the Information Age, such as the Samsung Galaxy S4. It functions as a phone, email client, Web browser, camera, video recorder, digital compass, and more. (Marian Stanca/Alamy)

In 1990 few people other than college professors used email. Today more than a billion people around the world have email accounts. Email messages are routed instantaneously for very low cost, which can be both a blessing and a curse. Business communications have never been so efficient, but it's not unusual to hear businesspeople complain that they can never get caught up with their email.

The World Wide Web was still being designed in 1990; today it contains more than a trillion pages and makes possible extraordinarily valuable information retrieval systems. Even grade school children are expected to gather information from the Web when writing their reports. However, many parents worry that their Web-surfing children may be exposed to pornographic images or other inappropriate material.

May Swenson has vividly described our ambivalent feelings toward technology. In her poem "Southbound on the Freeway," an alien hovers above an expressway and watches the cars move along [1]. The alien notes "soft shapes" inside the automobiles and wonders, "are they their guts or their brains?" It's fair to ask: Do we drive technology, or does technology drive us?

Our relationship with technology is complicated. We create technology and choose to adopt it. However, once we have adopted a technological device, it can transform us and how we relate to other people and our environment.

Some of the transformations are physical. The neural pathways and synapses in our brains literally change with our experiences. One well-known brain study focused on London taxi drivers. In order to get a license, aspiring London taxi drivers must spend two to four years memorizing the complicated road network of 25,000 streets within 10 kilometers of the Charing Cross train station, as well as the locations of thousands of tourist destinations. The hippocampus is the region of the brain responsible for long-term memory and spatial navigation. Neuroscientists at University College London found that the brains of London taxi drivers have larger-than-average hippocampi and that the hippocampi of aspiring taxi drivers grow as they learn the road network [2].

Stronger longer-term memory and spatial navigation skills are great outcomes of mental exercise, but sometimes the physical effects of our mental exertions are more insidious. For example, studies with macaque monkeys suggest that when we satisfy our hunger for quick access to information through our use of Web browsers, Twitter, and texting, neurons inside our brains release dopamine, producing a desire to seek out additional information, causing further releases of dopamine, and so on, which may explain why we find it difficult to break away from these activities [3, 4].

Adopting a technology can change our perceptions, too. More than 90 percent of cell phone users report that having a cell phone makes them feel safer, but once people get used to carrying a cell phone, losing the phone may make them feel more vulnerable than they ever did before they began carrying one. A Rutgers University professor asked his students to go without their cell phones for 48 hours. Some students couldn't do it. A female student reported to the student newspaper, "I felt like I was going to get raped if I didn't have my cell phone in my hand." Some parents purchase cell phones for their children so that a child may call a family member in an emergency. However, parents who provide a cell phone "lifeline" may be implicitly communicating to their children the idea that people in trouble cannot expect help from strangers [5].



FIGURE 1.2 The Amish carefully evaluate new technologies, choosing those that enhance family and community solidarity. (AP photo/*The Indianapolis Star and News*, Mike Fender)

The Amish understand that the adoption of a new technology can affect the way people relate to each other (Figure 1.2). Amish bishops meet twice a year to discuss matters of importance to the church, including whether any new technologies should be allowed. Their discussion about a new technology is driven by the question, “Does it bring us together, or draw us apart?” You can visit an “Old Order” Amish home and find a gas barbecue on the front porch but no telephone inside, because they believe gas barbecues bring people together while telephones interfere with face-to-face conversations [6].

New technologies are adopted to solve problems, but they often create problems, too. The automobile has given people the ability to travel where they want, when they want. On the other hand, millions of people spend an hour or more each day stuck in traffic commuting between home and work. Refrigerators make it possible for us to keep food fresh for long periods of time. We save time because we don’t have to go grocery shopping every day. Unfortunately, Freon leaking from refrigerators has contributed to the depletion of the ozone layer that protects us from harmful ultraviolet rays. New communication technologies have made it possible for us to get access to news and entertainment from around the world. However, the same technologies have enabled major software companies to move thousands of jobs to India, China, and Vietnam, putting downward pressure on the salaries of computer programmers in the United States [7].

We may not be able to prevent a new technology from being invented, but we do have control over whether to adopt it. Nuclear power is a case in point. Nuclear power plants create electricity without producing carbon dioxide emissions, but they also produce radioactive waste products that must be safely stored for 100,000 years.

Although nuclear power technology is available, no new nuclear power plants were built in the United States for more than 25 years after the accident at Three Mile Island in 1979 [8].

Finally, we *can* influence the rate at which new technologies are developed. Some societies, such as the United States, have a history of nurturing and exploiting new inventions. Congress has passed intellectual property laws that allow people to make money from their creative work, and the federal income tax structure allows individuals to accumulate great wealth.

Most of us appreciate the many beneficial changes that technology has brought into our lives. In health care alone, computed tomography (CT) and magnetic resonance imaging (MRI) scanners have greatly improved our ability to diagnose major illnesses; new vaccines and pharmaceuticals have eradicated some deadly diseases and brought others under control; and pacemakers, hearing aids, and artificial joints have improved the physical well-being of millions.

To sum up, societies develop new technologies to solve problems or make life better, but the use of new technologies changes social conditions and may create new problems. That doesn't mean we should never adopt a new technology, but it does give us a good reason why we should be making informed decisions, weighing the benefits and potential harms associated with the use of new devices. To that end, this book will help you gain a better understanding of contemporary ethical issues related to the use of information technology.

This chapter sets the stage for the remainder of the book. Electronic digital computers and high-performance communication networks are central to contemporary information technology. While the impact of these inventions has been dramatic in the past few decades, their roots go back hundreds of years. Section 1.2 tells the story of the development of computers, showing how they evolved from simple manual calculation aids to complex microprocessors. In Section 1.3 we describe two centuries of progress in networking technology, starting with the semaphore telegraph and culminating in the creation of an email system connecting over a billion users. Section 1.4 shows how information storage and retrieval evolved from the creation of the Greek alphabet to Google. Finally, Section 1.5 discusses some of the moral issues that have arisen from the deployment of information technology.

1.2 Milestones in Computing

Calculating devices have supported the development of commercial enterprises, governments, science, and weapons. As you will see in this section, the introduction of new technologies has often had a social impact.

1.2.1 Aids to Manual Calculating

Adding and subtracting are as old as commerce and taxes. Fingers and toes are handy calculation aids, but to manipulate numbers above 20, people need more than their

own digits. The tablet, the abacus, and mathematical tables are three important aids to manual calculating [9].

Simply having a tablet to write down the numbers being manipulated is a great help. In ancient times, erasable clay and wax tablets served this purpose. By the late Middle Ages, Europeans often used erasable slates. Paper tablets became common in the nineteenth century, and they are still popular today.

An **abacus** is a computing aid in which a person performs arithmetic operations by sliding counters along rods, wires, or lines. The first abacus was probably developed in the Middle East more than two thousand years ago. In a Chinese, Japanese, or Russian abacus, counters move along rods or wires held in a rectangular frame. Beginning in medieval Europe, merchants performed their calculations by sliding wooden or metal counters along lines drawn in a wooden counting board (Figure 1.3). Eventually the word “counter” came to mean not only the disk being manipulated but also the place in a store where transactions take place [9].

Mathematical tables have been another important aid to manual computing for about two thousand years. A great breakthrough occurred in the early seventeenth century, when John Napier and Johannes Kepler published tables of logarithms. These tables were tremendous time savers to anyone doing complicated math because they allowed them to multiply two numbers by simply adding their logarithms. Many other useful tables were created as well. For example, businesspeople consulted tables to compute interest and convert between currencies. Today, people who compute their income taxes “by hand” make use of tax tables to determine how much they owe.

Even with tablets, abacuses, and mathematical tables, manual calculating is slow, tedious, and error-prone. To make matters worse, mathematical tables prepared centuries ago usually contained errors. That’s because somebody had to compute each table entry and somebody had to typeset each entry, and errors could occur in either of these steps. Advances in science, engineering, and business in the post-Renaissance period motivated European inventors to create new devices to make calculations faster and more reliable and to automate the printing of mathematical tables.

1.2.2 Mechanical Calculators

Blaise Pascal had a weak physique but a powerful mind. When he got tired of summing by hand long columns of numbers given him by his father, a French tax collector, he constructed a mechanical calculator to speed the chore. Pascal’s calculator, built in 1640, was capable of adding whole numbers containing up to six digits. Inspired by Pascal’s invention, the German Gottfried Leibniz constructed a more sophisticated calculator that could add, subtract, multiply, and divide whole numbers. The hand-cranked machine, which he called the Step Reckoner, performed multiplications and divisions through repeated additions and subtractions, respectively. The calculators of Pascal and Leibniz were not reliable, however, and did not enjoy commercial success.

In the nineteenth century, advances in machine tools and mass-production methods, combined with larger markets, made possible the creation of practical calculating machines. Frenchman Charles Thomas de Colmar utilized the stepped drum gear mech-



FIGURE 1.3 This illustration from Gregor Reisch's *Margarita Philosophica*, published in 1503, shows two aids to manual calculating. The person on the left is using a tablet; the person on the right is adding numbers using a counting board, a type of abacus. (Heritage Images/Corbis)

anism invented by Leibniz to create the Arithmometer, the first commercially successful calculator. Many insurance companies purchased Arithmometers to help their actuaries compute rate tables more rapidly [9].

Swedish publisher Georg Scheutz was intimately familiar with printing errors associated with the production of mathematical tables. He resolved to build a machine capable of automatically calculating and typesetting table values. Scheutz knew about the earlier work of English mathematician Charles Babbage, who had demonstrated how a machine could compute the values of polynomial functions through the method of

differences. Despite promising early results, Babbage's efforts to construct a full-scale Difference Engine had been unsuccessful. In contrast, Georg Scheutz and his son Edvard, who developed their own designs, completed the world's first printing calculator: a machine capable of calculating mathematical tables and typesetting the values onto molds. The Dudley Observatory in Albany, New York, purchased the Scheutz difference engine in 1856. With support from the US Nautical Almanac Office, astronomers used the machine to help them compute the motion of Mars and the refraction of starlight. Difference engines were never widely used; the technology was eclipsed by the emergence of simpler and less expensive calculating machines [9].

America in the late 1800s was fertile ground for the development of new calculating technologies. This period of American history, commonly known as the Gilded Age, was characterized by rapid industrialization, economic expansion, and a concentration of corporate power. Corporations merged to increase efficiency and profits, but the new, larger corporate organizations had multiple layers of management and multiple locations. In order for middle- and upper-level managers to monitor and improve performance, they needed access to up-to-date, comprehensive, reliable, and affordable information. All these requirements could not be met by bookkeepers and accountants using pen and paper to sum long columns of transactions by hand [10].

To meet this demand, many entrepreneurs began producing adding and calculating machines. One of these inventors was William Burroughs, a former bank clerk who had spent long days adding columns of figures. Burroughs devised a practical adding machine and offered it for sale. He found himself in a cutthroat market; companies competed fiercely to reduce the size of their machines and make them faster and easier to use. Burroughs distinguished himself from his competitors by putting together first-class manufacturing and marketing organizations, and by the 1890s the Burroughs Adding Machine Company led the industry. Calculating machines were entrenched in the offices of large American corporations by the turn of the century [10].

The adoption of mechanical calculators led to the "de-skilling" and "feminization" of bookkeeping (Figure 1.4). Before the introduction of calculating machines, offices were a male bastion, and men who could rapidly compute sums by hand were at a premium. Calculators leveled the playing field, making people of average ability quite productive. In fact, a 1909 Burroughs study concluded that a clerk using a calculator was six times faster than a clerk adding the same column of figures by hand [11]. As managers introduced mechanical calculators into offices, they replaced male bookkeepers with female bookkeepers and lowered wages. In 1880 only 5.7 percent of bookkeepers, cashiers, and accountants were women, but by 1910 the number of women in these jobs had risen to 38.5 percent [12].

1.2.3 Cash Register

Store owners in the late 1800s faced challenges related to accounting and embezzlement. Keeping accurate sales records was becoming more difficult as smaller stores evolved into "department stores" with several departments and many clerks. Preventing embezzlement was tricky when clerks could steal cash simply by not creating receipts for some sales.



FIGURE 1.4 Mechanical calculators led to the “de-skilling” and “feminization” of book-keeping. (Underwood Archives/Getty Images)

While on a European holiday in 1878, Ohio restaurateur James Ritty saw a mechanical counter connected to the propeller shaft of his ship. A year later he and his brother John used that concept to construct the first cash register, essentially an adding machine capable of expressing values in dollars and cents. Enhancements followed rapidly, and by the early 1900s the cash register had become an important information-processing device (Figure 1.5). Cash registers created printed, itemized receipts for customers, maintained printed logs of transactions, and performed other accounting functions that provided store owners with the detailed sales records they needed.

Cash registers also made embezzlement by clerks more difficult. The bell made it impossible for clerks to sneak money from the cash drawer and helped ensure that every sale was “rung up.” Printed logs made it easy for department store owners to compare cash on hand against sales receipts [10].

1.2.4 Punched-Card Tabulation

As corporations and governmental organizations grew larger in the late 1800s, they needed to handle greater volumes of information. One of these agencies was the US Bureau of the Census, which collected and analyzed information on tens of millions of residents every decade. Aware of the tedium and errors associated with clerks manually copying and tallying figures, several Census Bureau employees developed mechanical