# Contents

Acknowledgments . . . . . xv
Foreword, by Paul Ehrlich and Anne Ehrlich . . . . . xvii
Introduction . . . . . xxiii

PART I: TECHNOLOGY AND ITS LIMITATIONS

1. The Inherent Unavoidability and Unpredictability of Unintended Consequences . . . . . 3
Interconnectedness . . . . . 3
Human Improvement upon Nature . . . . . 5
Unavoidable Negative Effects of Technology . . . . . 7
Irreversible Consequences . . . . . 8
The Limitations of Reductionism . . . . . 11

2. When Things Bite Back: Some Unintended Consequences of Modern Technology . . . . . 17
Unintended Environmental Consequences . . . . . 17
Unintended Consequences of Industrialized Agriculture . . . 23
Unintended Side Effects of Genetic Engineering . . . . . 25
Unintended Consequences of the Automobile . . . . . 28
Intended and Unintended Consequences of High-Technology Warfare . . . . . 31
Unintended Consequences of High-Tech Medicine . . . . . 33
Unintended Consequences of Technological Revolutions . . . 43
The Decline in Fitness of Future Generations . . . . . 46

3. Technology, Exploitation and Fairness . . . . . 49
Technology and Exploitation . . . . . 50
Technological Exploitation of Nature . . . . . 53
Human Domination of Nature . . . . . 56
Machines and the Control and Exploitation of Workers . . . . 60
Television: A Powerful Tool for Social Control and Manipulation . . . . . 64
Military Technologies . . . . . 68

4. In Search of Solutions I: Counter-Technologies and Social Fixes . . . 71
Counter-Technologies . . . 73
Social Fixes . . . 75
Environmental Counter-Technologies . . . 77
Military Counter-Technologies . . . 83
Medical Counter-Technologies . . . 86
Unintended Consequences of Counter-Technologies and Social Fixes . . . 88

5. In Search of Solutions II: Efficiency Improvements . . . 91
Technological Progress and Rising Material Affluence . . . 94
Efficiency Improvements and Limited Resources . . . 98
Inherent Limits to Efficiency Improvements . . . 109
Unintended Consequences of Efficiency Solutions . . . 112

6. Sustainability or Collapse? . . . 117
Sustainable Development and Eco-Efficiency . . . 119
Three Conditions for Long-term Sustainability . . . 122
Challenge #1: Serious Environmental Impacts of Large-Scale Renewable Energy Generation . . . 125
Challenge #2: Replacement of Non-Renewable Materials with Renewable Substitutes . . . 133
Challenge #3: Complete Recycling of Non-Renewable Materials and Wastes . . . 135
Sustainability or Collapse? . . . 137

PART II: THE UNCRITICAL ACCEPTANCE OF TECHNOLOGY

7. Technological Optimism and Belief in Progress . . . 145
Belief in Progress: A Brief History . . . 148
Comparison of Belief in Progress to Religious Faith . . . 152
Ignorance: The Basis of Most Techno-Optimism . . . 154
Medical Techno-Optimism . . . 159
Techno-Optimism and the Mass Media . . . 167
The Decline of Techno-Optimism . . . 169

8. The Positive Biases of Technology Assessments and Cost-Benefit Analyses . . . . . 173
An Overview of Cost-Benefit Analysis . . . . . 174
Problem #1: Boundary Selection and Externalization of Costs 176
Problem #2: Prediction of Potential Impacts and Selection of Appropriate Indicators . . . . . 180
Problem #3: Institutional Biases and the Perception of Costs and Benefits . . . . . 183
Problem #4: Monetization of Non-Market Values . . . . . 185
Problem #5: The Ethics of Cost-Benefit Analyses . . . . . 187
The Uncritical Adoption of the Automobile . . . . . 189
The Hidden Costs of Biofuels . . . . . 192
Limited Testing of the Effectiveness of Medical Therapies . . 194
Gross Domestic Product (GDP): A Biased Indicator of Economic Progress . . . . . 200

9. Happiness . . . . . 207
Technological Innovation, Consumerism and Materialism . . 208
Material Affluence and Happiness . . . . . 214
Explaining the Paradox . . . . . 216
Sources of Happiness . . . . . 224
The Destruction of Traditional Sources of Happiness . . . . . 226

10. The Uncritical Acceptance of New Technologies . . . . . 235
The Myth of Value-Neutrality . . . . . 235
The Myth of Autonomous Technology . . . . . 241
The Technological Imperative . . . . . 243
Technological Dependency and Loss of Freedom . . . . . 245
The Undemocratic Control of Technology . . . . . 248

11. Profit Motive: The Main Driver of Technological Development . . . . . 253
Technological Development as a Social Process . . . . . 253
Understanding the Meaning of Profit . . . . . 255
Profit Maximization and the Development of New Technologies . . . . . 258
Profit Maximization: Agriculture and Food . . . . . 261

Profit Maximization: Medical Care . . . 263
Profit Maximization: Military Technologies and Foreign Policy . . . 266

PART III: THE NEXT SCIENTIFIC AND TECHNOLOGICAL REVOLUTION

12. The Need for a Different Worldview . . . 271
The Power of Worldviews and Paradigms . . . 271
Conflicting Worldviews and Paradigm Shifts . . . 273
A Different View of Reality . . . 277
A Different View of the Economy . . . 279
A Different View of Science and Technology . . . 285
A Different View of Medicine . . . 286
The Need for Increased Awareness . . . 289

13. The Design of Environmentally Sustainable and Socially Appropriate Technologies . . . 295
Design Criteria for Environmental Sustainability . . . 295
Design Criteria for Social Appropriateness . . . 300
The Prevention of Unintended Consequences . . . 304
The Democratic Control of Technology . . . 306
Local Organic Agriculture: A Model of Environmentally Sustainable and Socially Appropriate Technology . . . 309

14. Critical Science and Social Responsibility . . . 313
The Myth of Value-Neutrality . . . 313
A New, Critical Science . . . 320
The Question of Responsibility . . . 325
The Problem of Professionalism . . . 328
The Need for Comprehensive Professional Ethics . . . 330
Toward a Critical Science and Engineering . . . 334

For Further Thought . . . 339
Bibliography . . . 355
End Notes . . . 383
Index . . . 415
About the Authors . . . 435