



Albert H. Teich

Tenth Edition

**TECHNOLOGY  
& THE FUTURE**

# TECHNOLOGY & THE FUTURE

Tenth Edition

Albert H. Teich  
*Editor*

*American Association  
for the Advancement of Science*

**THOMSON**  
  
**WADSWORTH**

Australia • Canada • Mexico • Singapore • Spain •  
United Kingdom • United States

# Contents

Topical Contents	xi
About the Editor	xv
Preface	xvii

## PART I THINKING ABOUT TECHNOLOGY 1

1. Does Improved Technology Mean Progress? 3  
*Leo Marx*
2. How Society Shapes Technology 13  
*Robert Pool*
3. The Technology of Shoelaces 22  
*Edward Tenner*
4. Can Technology Replace Social Engineering? 27  
*Alvin M. Weinberg*
5. Why I Am Not Going to Buy a Computer 35 ✕  
*Wendell Berry*
6. Technology and the Tragic View 41  
*Samuel C. Florman*
7. Do Artifacts Have Politics? 50  
*Langdon Winner*
8. Feminist Perspectives on Technology 67 ✕  
*Judy Wajcman*
9. Futuring Methods 80 ✕  
*Edward Cornish*

## PART II DEBATING TECHNOLOGY: 1960s STYLE 91

10. The Role of Technology in Society 93  
*Emmanuel G. Mesthene*
11. Technology: The Opiate of the Intellectuals 103  
*John McDermott*

**PART III DEBATING TECHNOLOGY: TWENTY-FIRST-CENTURY  
STYLE 113**

- 12. Why the Future Doesn't Need Us 115  
*Bill Joy*
- 13. A Response to Bill Joy and the Doom-and-Gloom  
Technofuturists 138  
*John Seely Brown and Paul Duguid*
- 14. Promise and Peril 144  
*Ray Kurzweil*

**PART IV DILEMMAS OF NEW TECHNOLOGY:  
TERRORISM AND CIVIL LIBERTIES 167**

- ✓ 15. Terrorism and Brittle Technology 169  
*Amory B. Lovins and L. Hunter Lovins*
- ✓ 16. Technological Vulnerability 174  
*Brian Martin*
- 17. How to Protect Against and Prepare for Terrorist Attacks 186  
*The 9-11 Commission*
- 18. Civil Liberties in a Time of Crisis 201  
*James X. Dempsey*

**PART V DILEMMAS OF NEW TECHNOLOGY: BIOETHICS 207**

- ✓ 19. The Dark Side of the Genome 209  
*Robert A. Weinberg*
- ✓ 20. Remarks by the President on Stem Cell Research 218  
*President George W. Bush*
- ✓ 21. Hard Cell: A Commentary on the President's Stem  
Cell Address 222  
*Thomas H. Murray*

**PART VI DILEMMAS OF NEW TECHNOLOGY:  
GLOBAL CLIMATE CHANGE 233**

- ✓ 22. Modern Global Climate Change 235  
*Thomas R. Karl and Kevin E. Trenberth*
- ✓ 23. The Bush Administration's Approach to Climate Change 244  
*Spencer Abraham*

**PART VII DILEMMAS OF NEW TECHNOLOGY:  
COMPUTERS AND INFORMATION 251**

24. An Unforeseen Revolution: Computers and Expectations,  
1935–1985 253  
*Paul Ceruzzi*
25. Computer Ethics 265 <  
*Tom Forester and Perry Morrison*
26. The Internet Under Siege 282  
*Lawrence Lessig*
27. The Humpty Dumpty Problem 293  
*Mitchell Kapor*
28. In the Age of the Smart Machine 304 <  
*Shoshana Zuboff*
29. The Logistics of Techno-War 312 ✓  
*Gene I. Rochlin*

**PART VIII CODA 331**

30. In Touch at Last 333 ✓  
*Seth Shostak*

# Preface

The tenth edition of *Technology and the Future* represents something of a milestone. The book has been in print since 1972. When, as a young academic at Syracuse University, I first came up with the idea of assembling a reader on technology, society, and the future, I saw the prospect of just getting it published as a long-shot. The field of technology and society was somewhere between small and nonexistent; futures studies were barely known in academia. The number of potential readers for a book of this nature was anybody's guess. The notion that it might go through nine subsequent editions and still be in print in 2005 never came close to entering my mind.

I thought that an appropriate way to mark this milestone might be to look back over the technological changes that have occurred since 1972 and try to identify the ten most significant ones *in terms of their impacts on our daily lives*. My list follows. It was *not* developed through the Delphi method, through a survey, or any other systematic means. It is basically the product of applied head-scratching, a time-tested methodology that I have used often in the past. Readers are welcome to comment on this list or, better yet, to make their own lists and e-mail them to me at <ateich@aaas.org>.

**1. Ubiquitous Computing.** In the early 1970s, most computers were still giant mainframes that resided in computation centers. The more advanced organizations had remote (*dumb*) terminals with which to communicate with the mainframe. The computers did calculations. Period. The notion of having a personal computer (with far more power) on one's desk—much less in one's briefcase or pocket—was beyond imagination. The idea that those personal computers would become instant communication devices, or that they could access a world-wide database, process text, print photos, play (and copy) music and videos, and do countless other things was similarly unimagined.

**2. The Internet.** One cannot discuss the significance of computers in the twenty-first century without considering the Internet. Its significance and the changes it has wrought cannot be overestimated. The basic concepts were developed in the late 1960s, but they were known only to a few computer scientists and engineers who were developing a network for the Defense Department. The first large-scale (*large-scale* being a relative term) public demonstration took place in October 1972. E-mail was invented the same year. But the Internet did not really take off until late 1993, with the advent of the World Wide Web.

**3. Wireless Technology.** The third element of the ICT (information and communications technology) field, intimately tied to computers and the Internet, of course, is wireless. Mobile phones, text messaging, wireless networking, Bluetooth, and other wireless technologies have untethered computers and communication devices, changing the way people live, work, and stay in touch with each other and the world.

**4. Biotechnology.** The life science revolution that began with the discovery of the double helix structure of DNA in the 1950s is only now beginning to fulfill its promise. From in vitro fertilization to designer drugs to prenatal diagnoses, gene therapy, genetically modified plants, human insulin manufactured by bacteria, and on and on, the new biology is making profound changes in human life. While these developments are regarded as blessings by most people, some of them—such as human embryonic stem cell research and cloning—raise troubling ethical and (in some instances) environmental issues.

**5. Medical Technology.** Closely related to the developments of biotechnology are other medical advances, many of which draw as much on the physical sciences and engineering as they do on biology. Included in this category are imaging technologies (CAT scans, MRI), artificial organs, synthetic joints, automatic external defibrillators, laser surgery, optical fiber probes that allow medical personnel to see inside blood vessels and other parts of the body, and many other technologies. These developments are saving lives, but they, too, raise social issues including costs, inequities in access, and, in some cases, wrenching decisions on when to terminate life support.

**6. Household Technologies.** Microwave ovens seem such a routine part of American life in the twenty-first century that it is easy to overlook them in thinking about technology's impact on our lives. But they, and the other labor-saving, entertainment, and comfort-enhancing devices that can be found in most of our homes these days, have influenced lifestyles in important ways. Microwave ovens, for example, have made it much easier for women to participate in the workforce while still maintaining their traditional roles in preparing meals and running a household (though not always easily). These, together with a variety of other innovations, have allowed us to live the busier lives that we do today—which many of us regard as a mixed blessing.

**7. Technologies that Reduce Human Interaction.** When was the last time you got cash from a bank teller? Had someone pump gas for you? Bought an airplane ticket from an agent in a ticket office? Automatic teller machines, self-service gas stations, and Internet shopping have eliminated many routine human interactions. At the same time, personal music players—from the Walkman, introduced in 1979, to today's iPods and tiny mp3 players—allow us to tune out our immediate surroundings and sounds and create a personal space to carry around with us, further limiting our contacts with other humans. The social impacts of these technologies are only beginning to be studied.<sup>1</sup>

**8. Transportation Technologies.** In 1972, air travel had just begun its transformation from an elite form of travel to airborne mass transit. Many people still dressed up to take a flight. Airline fares were regulated by the federal government and kept artificially high. Low-cost air travel did not begin until 1971 when Southwest Airlines was founded, flying within a single state (Texas) to escape federal regulation. Coincidentally, that year, Federal Express (now FedEx) began operations, revolutionizing the package delivery industry. Today we expect our

<sup>1</sup> See, for example, Michael Bull, *Sounding Out the City: Personal Stereos and the Management of Everyday Life* (New York: NYU Press, 2000).



purchases and our urgent mail and packages to be delivered overnight. Less visible to most of us but even more profound in its impacts is container shipping, which has made possible global commerce at a pace and scale hardly imagined 50 years ago. Today, 90 percent of the world's trade moves in containers; a standard shipment from Hong Kong to New York, which took approximately 50 days in 1970, today takes only 17.

**9. Scientific Instruments and Techniques.** The feedback loop between technology and science has had an important influence on modern society. Science produces the knowledge base on which technology draws; technology produces instruments and methods that advance science. Take, for example, environmental science. Environmental groups and government regulatory agencies are concerned about pollutant concentrations in air and water that were below the level of detection by the most sensitive instruments 30 years ago. Our understanding of and ability to respond to global climate change, ozone depletion, the health effects of pollutants, and the global spread of diseases (such as West Nile Virus) is only possible because of scientific instruments and methods developed in recent years.

**10. Financial Services.** It's hard to imagine our society without credit cards. The concept has been around since the 1920s, but Diners Club, the first credit card that could be used in many unrelated businesses, did not come into existence until 1950, and American Express followed in 1958. Visa and MasterCard, which brought credit cards to tens of millions of people, got their start in the 1960s, but gained widespread acceptance only in the 1970s. The worldwide diffusion of this technology, as well as the numerous other financial service innovations of the past several decades (in banking, the stock market, corporate finance), would not be possible without today's computers and the networks that connect them.

I have not tried to rank these technological developments in order of importance. There are many reasons why it does not make a great deal of sense to do so, but perhaps the most important one is the interrelatedness of so many of these technologies. Computers (e.g., microchips), especially, are integral to virtually everything on the list. In fact, the interrelatedness of modern technologies may be one of the most salient facts about them. This is something to bear in mind in thinking about the mutual impacts of technology and society (one of the themes of this book) and considering the prospect of eschewing certain technologies as some of the writers in this volume (e.g., Wendell Berry and Bill Joy) would have us do.

This edition of *Technology and the Future* is the most significant update and revision of the book in many years. More than a quarter of the articles are new, most published in the past year or two. The organization of the book has also changed significantly. In Part I, "Thinking about Technology," the authors raise big questions: What is technology? Is it good, bad, or neutral? Is it synonymous with progress? How does it influence society? This section has been expanded by the addition of a chapter by Edward Tenner, author of the best-selling *Why Things Bite Back*, in which he considers shoelaces (!) as a technology, and a chapter by Edward Cornish, dean of American futurists, which provides a brief introduction to the methods of futures research. In addition, the chapters by Langdon Winner (difficult, perhaps, but well worth the effort) and Judy Wajcman (on feminism and technology) have moved up to this section from elsewhere in the book. Part I



also preserves the best elements of previous editions in order to introduce readers to the process of thinking about technology.

The dated, but still very relevant, debate over the role of technology in society between the late Emmanuel Mesthene and John McDermott, a feature of the book since the first edition, comprises Part II, entitled, "Debating Technology: 1960s Style." Both the substance and the rhetoric of the Mesthene-McDermott debate contrast with Part III, "Debating Technology: Twenty-First-Century Style," in which Bill Joy, a computer scientist responsible for several major software innovations, presents his rather scary vision of a future in which nanotechnology, genetics, and robotics converge and threaten the existence of humanity. Responding to Joy are John Seely Brown and Paul Duguid, as well as inventor Ray Kurzweil (new to this edition), a friend of Joy's who disagrees profoundly with his view of the future.

The following four sections turn to more concrete issues and explore some of the ethical, social, and human dimensions of specific areas of technology. Reflecting a heightened sensitivity to the fragility of our technological society, Part IV presents four articles on terrorism, homeland security, and the civil liberties issues raised by the government's responses to 9/11. Amory and Hunter Lovins discuss the "brittleness" of the complex, centralized systems we have created. Australian scholar and social activist Brian Martin dissects the issue of technological vulnerability. New to this edition are a chapter from the *Report of the 9/11 Commission* detailing the Commission's suggestions for protecting against terrorist attacks and an article by James X. Dempsey that looks critically at the USA PATRIOT Act and the tension between freedom and security.

Part V focuses on a technological area that is certain to play a key role in our future—genetics and biotechnology. This section includes discussions of the exquisitely difficult dilemmas posed by our growing knowledge of molecular genetics and biotechnology—differing perspectives on the controversial issue of stem cell research, including President George W. Bush's August 2001 address to the nation on that subject and an examination by a prominent biologist of the possibilities for choosing traits in our offspring.

Part VI is entirely new to this book. It brings in the complex issue of global climate change with an article by two top researchers explaining the science on which the scientific community consensus on this subject is based and another by Spencer Abraham, secretary of energy in the Bush administration, describing the administration's response to the problem. The article on the climate change science is somewhat more technical than others in this book, but for anyone who wants to understand why most scientists believe it is a very serious problem, it's highly recommended.

Under the heading of information technology in Part VII are articles on why those who created the IT (information technology) revolution failed to anticipate its extent or its impact; a broad-based survey of the ethical issues raised by computers and information technology; and discussions of the impact of computers on the organization and character of work and on warfare. Complementing an article by Lawrence Lessig, in which he expresses concern that the promise of the Internet is being wasted as outmoded ideas choke off its innovative potential, is a new article by Mitch Kapor (developer of Lotus 1-2-3 and co-founder of the Electronic

Frontier Foundation) discussing the impact these technologies are having on the entertainment world and on intellectual property more generally.

In the final section, Part VIII, astronomer Seth Shostak's short story, "In Touch at Last," provides some entertaining and thought-provoking speculation on perhaps the ultimate scientific or technological achievement—discovery of extraterrestrial intelligence.

As in previous editions, my selections are a mixed bag. Not all students or all instructors will find all of the readings to their liking. Readers will probably love some and hate others, find some fascinating, others tedious. The individual essays do not represent my own views, and I do not necessarily endorse their perspectives. As a whole, however, the book reflects what I hope is a balanced view of the important issues in the field of technology and society, a view that I hope will be useful to others who are interested in these topics.

*Technology and the Future* has been a part of my life throughout most of my professional career. It is gratifying to have watched the growing interest in the study of technology, society, and the future in American colleges and universities over the past three decades and to feel that the book may have made a modest contribution to this important intellectual development. Throughout the life of this book, I have benefited from the interest, suggestions, and feedback from the book's users. I am indebted to them all for the ideas that they shared with me, some of which have helped to shape this volume.

My thanks go also to the staff of my current publisher, Thomson Wadsworth, to Bedford/St. Martin's, and finally to St. Martin's Press's College Division, whose editors had the foresight to publish the first edition of this book in 1972 and who, through a generation of staff changes, mergers, acquisitions, and restructurings, remained helpful, interested, and unfailingly supportive. I have been fortunate in having a series of editors over the years with whom it has always been a pleasure to work.

I wish to acknowledge the advice of those who have contributed to this edition: Larry Bland, John Brown University; Donald R. Dixon, California State University—Sacramento; Charles Korte, North Carolina State University; Lisa Osbeck, State University of West Georgia; Robert Oxley, Embry-Riddle University; and James Thompson, University of Illinois—Chicago.

Finally, a very special note of gratitude goes to my family: my wife, Jill; my daughter, Samantha; and my grown sons, Mitch and Ken; their wives Gretchen and Sara; and my grandchildren, Calvin Avery, Madelyn Elise, and Sylvi Reine for the meaning they have given to my life and for the strength I draw from our relationships.

Once again I invite readers—both faculty and students—to contact me with comments and suggestions. I can be reached most readily by e-mail at <ateich@aaas.org>, or through the links on my website, which can be found at <<http://www.alteich.com>>. The website also contains supplementary resources related to the book, including links to more information about the authors of the various articles, tables of contents of earlier editions, the full text of several hard-to-find articles from earlier editions, my personal home page, and more.

Albert H. Teich  
Washington, DC  
March 2005