Introduction

Techno-optimism is pervasive in our society but hardly justified. In one form or another, we are repeatedly assured that "More efficient technology will solve the problem," "Continued economic growth is environmentally sustainable," "High-tech medicine and miracle drugs will abolish disease," "More military spending will ensure global peace and security," "Biofuels and nuclear power are the solution to global warming," "Overpopulation is not a problem—we will employ genetically engineered crops to feed an unlimited number of people," "Greater material affluence will increase happiness," "We have no choice anyway: technology is an autonomous force. Whatever can be done technologically, should be and will be done," "You can't put the genie back in the bottle."

Techno-Fix confronts these beliefs and many others. It questions a primary paradigm of our age: that advanced technology alone will extricate us from an ever-increasing load of social, environmental and economic ills. *Techno-Fix* shows why negative unintended consequences of science and technology are inherently unavoidable and unpredictable, why counter-technologies, techno-fixes and efficiency improvements do not offer lasting solutions and why modern technology, in the presence of continued economic growth, does not promote sustainability but instead hastens collapse.

Despite the serious shortcomings and consequences of past technologies, the public often uncritically accepts new technology, believing that additional and more advanced technology will eventually provide satisfactory solutions. *Techno-Fix* analyzes this paradox and asserts that technological optimism and the unrelenting belief in progress are based on ignorance, that most technological cost-benefit analyses are biased in favor of new technologies and that increasing consumerism and materialism, which have been facilitated by science and technology, have failed to increase happiness. The common belief that technological change is inevitable is questioned; the myth of the value-neutrality

of technology is exposed; and the ethics of the technological imperative "what can be done, should be done" is challenged. Instead, the profit motive of corporations is identified as the main determinant of the direction of technological change. *Techno-Fix* asserts that science and technology, as currently practiced, cannot solve the many serious problems we face and that a paradigm shift is needed to reorient science and technology in a more socially responsible and environmentally sustainable direction.

Techno-Fix is one of the few, if not the only, comprehensive discussions of modern technology written not by philosophers, historians or journalists but by two inside observers of the technological scene. Michael holds a doctorate in chemical engineering and has an extensive background in environmental science, economics and business, as well as more than 25 years' experience in environmental research. Joyce holds a doctorate in applied mathematics and a master's degree in anthropology. Being educated and experienced in science and engineering, the authors are uniquely positioned to deliver an insightful and powerful critique of modern technology.*

The readers of *Techno-Fix* will learn a number of inconvenient truths about science and technology, topics that are rarely, if ever, covered in the media or discussed among professionals. Readers will be challenged to re-examine their current worldviews, their paradigms and assumptions about the so-called promises of modern technology. But they will also enjoy their newly gained knowledge and will feel empowered and inspired by the fact that most problems confronting humanity have inherently simple, low-tech solutions that do not rely on excessive technology.

Who should read *Techno-Fix*? Anyone interested in protecting nature; anyone concerned about the effects of technology on society and the environment; anyone teaching or studying science, engineering, medicine or related disciplines; anyone intending to create a better future.

The following is a brief overview of the chapters.

Part I: Technology and its Limitations addresses a number of important questions regarding modern technology: What kind of unin-

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* The opinions expressed in this book are solely those of the authors and do not reflect the views of the authors' current or previous employers, their clients or the US government.

tended environmental and social consequences are associated with advanced technologies? Could they have been predicted and avoided? Are counter-technologies, social fixes and efficiency improvements really effective in solving the problems brought about by modern science and technology? Does increasing technology promote sustainability or accelerate collapse?

Chapter 1: The Inherent Unavoidability and Unpredictability of Unintended Consequences postulates that there are always positive and negative effects of any technology. It is impossible for humans to substantially modify natural systems without creating unanticipated and undesirable consequences. Furthermore, technological consequences may become irreversible if the magnitude and speed of change is greater than the adaptive capacity of the environment, ourselves or other species. Finally, modern science, because of its foundation of mechanistic reductionism, is intrinsically unable to predict all deleterious side effects.

Chapter 2: When Things Bite Back explores, in depth, some of the many unintended environmental and social consequences of modern technologies, ranging from environmental pollution, global warming, species extinction, topsoil loss and ecological disruptions by genetically engineered organisms to social alienation; death and destruction brought about by chemical, nuclear and other high-tech weaponry; antibiotic resistance; human overpopulation and the decline in biological fitness.

Chapter 3: Technology, Exploitation and Fairness advances the thesis that many technologies are regrettably used for control and exploitation of both humans and the environment, leading inevitably to detrimental consequences for those exploited.

Chapter 4: In Search of Solutions I: Counter-Technologies and Social Fixes discusses the limitations of technologies that attempt to counter the negative effects of previous technologies and also shows why technological solutions to social, economic, political and psychological problems are often ineffective because they generally address symptoms rather than causes.

Chapter 5: In Search of Solutions II: Efficiency Improvements analyzes a wide range of historical data to demonstrate that most efficiency improvements have not been able to halt or reverse the growth in the

use of limited resources but instead accelerate their consumption, a phenomenon called the rebound effect or the Jevons paradox.

Chapter 6: Sustainability or Collapse? argues that there are at least three critical technological challenges that must be met in order to produce long-term sustainability: avoiding serious environmental impacts associated with the large-scale generation of renewable energy, replacing non-renewable materials with renewable substitutes, and completely recycling non-renewable materials and wastes.

Part II: The Uncritical Acceptance of Technology addresses key questions relating to the naïve acceptance of new technologies despite the many negative consequences and limitations discussed in Part I. Why do we believe in technological progress? Is the current exuberant technological optimism justified by the evidence? Are technology assessments and cost-benefit analyses really objective and unbiased? Why do we still believe that increasing material affluence will increase happiness despite evidence to the contrary? Is technology value neutral and autonomous, as is often claimed? Is it prudent to follow the technological imperative "Whatever can be done, will be and should be done"? How democratic is technological decision making? Should profit maximization remain the primary criterion for the selection of new technologies?

Chapter 7: Technological Optimism and Belief in Progress postulates that belief in progress exhibits characteristics similar to those of religious faith and that most techno-optimism is based on ignorance, enabling the corporate-controlled mass media to present new technologies and products in an overly favorable light to a gullible public.

Chapter 8: The Positive Biases of Technology Assessments and Cost-Benefit Analyses demonstrates how each step in the standard cost-benefit analysis procedure has intrinsic problems and ambiguities, some of which are specifically exploited, knowingly or unknowingly, to produce positive recommendations for the development and diffusion of technologies even when they are of marginal or of no benefit.

Chapter 9: Happiness provides extensive evidence that material affluence, consumerism and economic growth brought about by advances in science and technology have failed to improve psychological well-being and, at the same time, have weakened or destroyed many non-materialistic and traditional sources of happiness.

Chapter 10: **The Uncritical Acceptance of New Technologies** discusses five topics related to the widespread belief in the inevitability of technological change: the myth of value-neutrality, the technological imperative, the loss of freedom and technological dependency, the myth of autonomous technology, and the undemocratic control of technology.

Chapter 11: Profit Motive: The Main Driver of Technological Development demonstrates that profit maximization does not necessarily lead to the development of technologies and products best suited to meet the needs of people in terms of food, health and security.

Part III: The Next Scientific and Technological Revolution poses critical questions about the future of science and technology. Because most problems caused by science and technology in the past were created within the dominant worldview characterized by excessive individualism and the goals of control and exploitation, a paradigm shift to a different view of reality is needed to solve fundamental problems. A more realistic paradigm would lead to a change in the form of economic activities as well as to changes in the practice of science and technology. How could such a paradigm shift be brought about? Can technologies be designed to be environmentally sustainable and socially appropriate while minimizing unintended consequences? What are the characteristics of a self-correcting, critical science? Do science and engineering professionals have social responsibilities?

Chapter 12: The Need for A Different Worldview suggests that a shift is needed to a different view of reality, one that is based on the fact of interconnectedness rather than the illusion of separateness, a view that would result in a change from a growth economy to a steady-state economy and to a change in how science is performed, technology applied and medicine practiced.

Chapter 13: The Design of Environmentally Sustainable and Socially Appropriate Technologies suggests specific environmental and social design criteria for new technologies, the importance of the precautionary principle in preventing unintended consequences, and the need for a more democratic control of technology.

Chapter 14: Critical Science and Social Responsibility outlines ways to increase the awareness of scientists and engineers regarding their social responsibilities as well as ways to transform current science into a critical, self-reflective and self-correcting science.

The arguments advanced in *Techno-Fix* are supported by extensive research, with more than 1,200 footnotes citing at least 600 references, primarily from peer-reviewed academic publications. Key points are also supported by quotations from authorities and original thinkers such as Rachel Carson, Barry Commoner, Herman Daly, Paul and Anne Ehrlich, David Korten, Jerry Mander, Donella Meadows, Jeremy Rifkin, E.F. Schumacher, and E.O. Wilson. In the Appendix, suggestions "For Further Thought" invite readers to engage in critical analyses themselves.

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