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Introduction

Technology is a powerful component of the modern world. Its influence can be clearly seen in the fact that many of the iconic accomplishments of modern societies are technological in nature. For instance, the twentieth century was marked by the construction of the Panama Canal; the invention and widespread adoption of the automobile, airplane, radio, and television; the moon landing; the development of the atomic bomb; and the development of computers and information technologies. Technologies have at least partly empowered even recent, seemingly nontechnological achievements made around the world. For instance, birth control pills helped enable women's liberation, and the invention of the Internet spurred the emergence of new democracies across the globe. Technology has been an important factor shaping the character of human societies and individual lives for millennia, but in looking back over the last century, it is evident that the power of technology to change the way we live is undeniable and awe inspiring.

Technologies not only have contributed to broad social and political change but have permeated almost every dimension of daily life in industrialized societies. Refrigerators, coffee makers, and microwave ovens make certain foods easy for us to obtain and others more difficult. Washing machines, pharmaceuticals, electric toothbrushes, and exercise equipment all shape our health and hygiene. The clothes we wear, the banks we put our money into, and the jobs we hold are all impacted or even made possible by global systems that exist only because of the complex technological systems they're built on. We maintain our personal as well as our working relationships through a global communications network. We entertain ourselves by means of digital technologies in which the quality of audio and images improves year after year. In short, a wide range of technologies are now an essential part of our work, play, education, health, finances, child-rearing, and even reproduction.

Modern societies have embraced technologies for a variety of reasons, but broadly speaking, new technologies offer new opportunities and the promise of improved lives. Technologies have been used to solve problems that have plagued humanity for centuries, eradicating diseases, harnessing new energy resources, and providing rapid transportation. Developers of technology have also pointed out needs we never knew we had to justify the creation of new devices, including eliminating bad breath, providing the convenience of shopping at home, and offering new forms of entertainment such as interactive games.

While technologies have helped us create a truly amazing world, it is clear that numerous problems remain. Our goal is and should be to make the world a better place for ourselves, for those around us, and for those who will come after us. To achieve this better future, we will need to direct technology toward the values we want to promote.

If new technologies solve problems and make our lives better, then we might expect continuous technological development to bring constant improvements in human lives. Visions and predictions of the future are often based on the idea that new technologies will bring about social change—that in and of themselves, technologies create the future. But we must be careful not to confuse technological change with social and human progress. We may be better off in some ways and worse off in others as a result of adopting certain technologies.

Technologies rarely, if ever, change the world in a clear, singular way. When we integrate them into our society, they often have far-rippling effects that are not always positive. Economies have been built on the wealth and benefits generated from manufacturing, but many manufacturing techniques degrade our environment and living conditions through the pollutants they produce. Social media has allowed us to share our views with people on the other side of the planet but may also make the measured, thoughtful discourse necessary for democracy more difficult. In addition to what some deem “side effects,” new technologies can also lead to (desirable or undesirable) shifts in power from one group to another. For example, the computational power of large mainframes has enabled the growth of huge organizations, making it harder and harder for small companies to compete. In some cases, the impacts of new technologies have become perceptible soon after development—like the atomic bombs dropped on Hiroshima and Nagasaki. With other technologies, the implications have manifested more slowly—such as damage to the environment from chemical pesticides and fertilizers generated and accumulated over the past few centuries.

What exactly counts as a “negative implication” of a technology is up for debate as well because technologies affect different groups of people differently. The benefits may go to some segments of a population while the burdens are borne by other groups. This is the case, for example, with toxic waste disposal plants, which are generally located in poor nonwhite communities, putting those who live nearby at increased health risk while citizens living farther away reap the benefits. Technologies can reinforce prevailing inequalities, but they can also disrupt status quo arrangements. Think here of how new online news services have put print newspapers out of business or consider how the threat from autonomous vehicles may disempower those who drive vehicles for a living. Thus, while technology must be part of the solution in making a better world, we must also be mindful that simply “adding” technology would not necessarily create a world we want to live in.

The good news is that technology doesn’t just happen. It doesn’t just come out of nowhere. A wide range of social forces create and shape technologies. We all make decisions that shape or direct the development and use of technologies. For instance, venture capitalists and government officials decide in which areas of science and engineering to invest their resources. Corporate executives choose the types of products they will bring to market. Engineers design technologies with certain features and applications. Marketers evaluate how technologies may best be presented to the public. Regulators specify standards to help ensure that industries develop products that are safe and efficient. Advocates working with nongovernmental organizations (NGOs) encourage the development of alternative technologies that corporations may have overlooked, as well as voice concerns about technologies they believe governments should regulate. Finally, every individual decides whether, where, when, and how to use new technologies at home, in public places, and at work.

The fact that technologies don’t just “happen” to society but are the result of social shaping means that influencing and even steering the trajectory of technological

developments is possible, albeit not easy. The challenge is daunting because so many different actors and factors can affect the development of technology. Often, decisions are difficult to make because they involve competing values. For instance, those who want to save the world through clean energy have come face-to-face with those whose lives and fortunes have been invested in older energy systems—including everyone from big oil companies to Native American tribes with economies based on their coal reserves. In this situation, not everyone can get what they want. The competing values must be resolved. Usually those with power, money, and prestige are in the best position to resolve issues like this in their favor. Thus, too often, new technologies make the world a better place for the “haves” rather than the “have nots,” worsening the inequities that already exist.

When it comes to the future, the fact that human decisions influence technological development is liberating. It means that no vision of the future is inevitable. The actions of today influence outcomes that will constitute the shape of the future. This book has been designed with the idea that readers, like the authors, want the future to be a good place for humanity. We want the future to be better than the present. Among other things this means that we want future technologies to constitute human lives, organizations, governments, and economies in ways that fulfill human needs and enhance human well-being—and do so for all. Such a goal is, we acknowledge, idealistic, but we believe the alternative is unacceptable.

In order to influence the development of technology in whatever way—large or small—it is essential to understand the relationships between technology and society. This book is designed to do just that. Although there are limits to what individuals can do to influence the direction of technological development, the idea of the book is to provide an understanding of how technology and society intertwine that will be helpful to anyone whose decisions affect the future. Whether you are a consumer of technology, a user of technology, a policy-maker, a constituent, an engineer, or a business leader, if you want to direct technology in the most beneficial ways, you need to understand how people shape technology and how technology shapes people. While we are constantly surrounded by devices and tools and often know how they work mechanically, we don’t always know where they came from and what it takes to make them work, and we generally don’t think much about the social effects they can have. We need an understanding of how machines, devices, and techniques are interwoven with people, institutions, goals, and values if we are going to work for better futures.

A fundamental way this book seeks to further this concept is by rethinking the very idea of technology. The book argues, implicitly as well as explicitly, that technology does not just comprise material objects—or *artifacts*. Technology neither exists nor has meaning without the human activities of which it is a part. Similarly, many social practices would be impossible or incomprehensible without material objects. As such, to understand the ways in which technology permeates and constitutes our everyday lives, we have to examine material objects together with the social practices and social relationships that make such material objects possible and useful. This book and most of the authors in it approach technologies as *sociotechnical systems*, rather than individual devices or machines.

For example, to understand how technologies develop and change over time, it is important to examine the ways that human decision-making influences design. One of the most prominent and influential technologies of the twentieth (and probably the twenty-first) century—the automobile—has been subject to countless forces seeking to shape its design. Engineers, designers, policy-makers, consumer advocacy groups, and

consumers themselves have all had an impact on automotive design, with the hopes of promoting their specific goals. Everything from the tail fins of the 1950s to the catalytic converters of the 1970s was a result of the values of a different social group or groups to shape the cars ultimately offered to the public. If you don't consider the social and political forces that inspire it, automobile design probably won't make much sense.

The intertwining of human behavior and technological operations can also be thought of in terms of how things work. Technological devices only work through a combination of human behavior and machine behavior. Even something as simple and seemingly autonomous as a thermostat yields useful results only when the right human and machine inputs have been entered into the system. Although the thermostat receives temperature input and automatically responds by altering the functioning of the furnace and air conditioner, it must be built and installed by a human, and a human needs to set the temperature.

To provide an understanding of technology as a sociotechnical system, the book begins by presenting a selection of visions of the future. Each vision recognizes a connection between technology and society, but each vision and connection is distinctive. The selections raise many questions about the future we might be headed for, the opportunities for change created by new and evolving technologies, the processes by which technologies affect and constitute aspects of human societies and modes of life, and the importance of playing an active role in shaping our collective future.

Although we have suggested that the relationship between technology and society is so interwoven that the two are inseparable, the relationship need not, by any means, be a black box. In the last half century in particular, a new field of study known as STS (science and technology studies or science, technology, and society) sprang up as scholars began theorizing about the social aspects of science and technology. In the second section, we present several of the major theories that have been put forward, contested, and used. We offer these theories and the associated concepts as tools to aid in understanding technology's role in the past, present, and future.

One of the most important aspects of this relationship centers around human and social values and how they are embedded in technological choices. Values shape and are shaped by technology. The readings in the third section illustrate this point by focusing on a particular value in a particular context and time period. These selections suggest the importance of recognizing values in technological decision-making for the future and offer examples of how one might promote specific values through technology.

In trying to get a handle on how values shape and are shaped by technological decisions, we have intentionally selected readings that illustrate how race and gender are entangled with technology. The absence of race and gender from early theorizing in technology has begun to be remedied through research documenting just how subtly and complexly race and gender come into play in technological design and decision-making. To promote continuing work in this area, race and/or gender are addressed in every section of the book.

None of the theories about the technology-society relationship claims that the relationship is simple. The readings in the fourth section identify and illustrate the interesting and sometimes subtle complexities. These readings show that we (individually and collectively: e.g., as countries, cultures, or organizations) must think carefully about the technological choices we make.

We end the book with a set of readings that focus on sociotechnical challenges we currently face. How can we fulfill energy needs without destroying the environment or

worsening social inequities? In seeking security, how should we respond to and distinguish cybercrime and cyber acts of warfare? How will we understand what it means to be a person when scientists can tinker with the brain to affect attitudes and behavior? How can privacy be protected while at the same time achieving security, connectedness, and efficiency? These are challenges both in the short and long term, and they are unquestionably daunting. It is impossible to posit every challenge we face in a single section, but the readings provide examples of people struggling to address hugely important issues, and some even identify plausible strategies and solutions. These articles serve as a model for how to approach complicated sociotechnical systems with an eye toward making a difference. If we care about the future, we cannot just sit back and watch. We must face the issues, try to determine what has created the situation, and work to steer in a direction that will bring about a better sociotechnical future.

The ultimate intent of this book is to equip readers to be agents of change in our sociotechnical future. It offers a way to think about technology and society that can lead to improved technologies and a society better equipped to determine future outcomes. Whether you are an engineer, a policy-maker, a tinkerer, or simply a concerned citizen, you are more likely to make a difference if you understand the complexities of technological decisions. Such a journey will certainly not be easy, but this book will encourage and guide in that endeavor.