

Preface

In the mid-1980s I was a graduate student of Industrial and Systems Engineering at Purdue University in Indiana. My research revolved around the topic of how to make computers easier for people to use. At that time the fields of artificial intelligence and robotics were still in their infancy; and a human was a component of every system, either providing manual input or performing supervisory control. With a human brain containing about 85–100 billion neurons and approximately 100 trillion synapses, and with sensors containing remarkable capabilities, determining how technology could best serve humans was a challenging research topic. The theme that the purpose of technology was to serve as a tool for humans, was the dominant view when I was a graduate student in engineering and still is. But later my thinking about technology with regard to its role in serving humanity was to change, and eventually led to the writing of this book. While at Purdue, with limited space for graduate students, I shared an office with other students who were studying aeronautical engineering, manufacturing, and robotics. As I engaged my fellow graduate students in conversation about the topic of their research, I realized that while I was trying to design systems that were easier for humans to use, the other graduate students were trying to design systems that were completely automated; that is, had no human in the system at all. These fascinating and wide ranging discussions were my first introduction to robotics, artificial intelligence, and automation.

After graduation, I took a faculty position and did work primarily in the area of virtual reality, augmented reality, and wearable computers and taught a course on the supervisory control of robots. As my career developed, I became interested in more of the big picture of how technology, science, and policy interrelated. This new line of thinking led me to papers in the area of human rights (for artificial intelligence) and intellectual property, which then led me to law school and later to the LLM program in intellectual property law and policy at the University of Washington. This book details much of my engineering knowledge regarding the design of systems for human use, my formal training in law, and from years of

research and scholarship on the design of virtual and augmented reality systems and wearable computers.

While in graduate school I became aware of another accelerating trend occurring in technology—the enhancement of humans using techniques that were just being discovered in genetics, and the practice of equipping humans with biotechnology to treat a range of disabilities. For frame of reference, in the early 1980s, William DeVries implanted an artificial heart, the Jarvik-7, in a patient with the intention that the implant be long-lasting (it worked for a few months). More recently, French heart transplant specialists developed a prototype of the world's first fully implantable artificial heart, designed to beat for at least five years. Since the first attempts at using technology to enhance humans, advances in technology have led to the ability to replace or enhance a surprising amount of human physiology and anatomy. In fact, over the coming decades, humankind will, for the first time in the history of our species, be able to actively supersede our own physiology and anatomy. And as the nascent technology of prosthetics and neuromorphic chips develops, sometimes this century we may be able to bolster our memory and recall with brain implants; and to think faster, focus our attention better, react faster, run more swiftly, and possibly have superhuman strength. When I consider the enhancement of the human body with technology, my conclusion is that we are in the process of becoming the technology, and not just the passive recipient of its benefits.

For a host of reasons, technology is being developed and used for many purposes thought not possible even a few years ago: for example, assisting the handicapped and disabled (restoring sight for the blind, sound where there is a hearing deficit, or equipping people with exoskeletons to enable movement for those lacking mobility); for those who want to hack their body (a term used for people who seek to self-modify their body to extend the range of their senses, the topic of a chapter in this book); and ominously, for the cyborg-soldier of the future. However, while humans are being equipped with more-and-more technology, our cognitive abilities, which derive from our genetic blueprint, have remained relatively the same for thousands of years. In contrast, operating under the law of accelerating returns, which states that the rate of technological change is exponential, machines are quickly gaining in intelligence, sensory, and motor capabilities.

While technology is being used to enhance human capabilities, fight disease, and to allow new forms of expression, technology itself is becoming smarter, more human-like (i.e., an android, which is a robot designed to have a human appearance), and before midcentury could exceed humans in intelligence (referred to as the Singularity, the topic of Chap. 2). If so, a number of policy and legal issues will ensue regarding the relations between humans and our intelligent machines. Often when challenged by advances across many areas of human endeavor, our relevant laws and governmental policies have lagged behind technological breakthroughs. Consider the ethical, policy, and legal issues raised by the use of drones, or with autonomous robotic soldiers should they enter the battlefield. How about tort law and specifically negligence and strict liability when robots harm humans, or from

a social justice perspective, the deep digital divide which may result when some humans are physically and cognitively enhanced by technology and others are left behind? Further, consider how humanity should respond if artificially intelligent machines attain or surpass human levels of intelligence and argue for rights. For example, should we extend the rights that humans receive in most industrialized nations—such as political rights and liberties, to artificially intelligent machines; or would it be prudent to deny such rights to nonhuman beings? And finally, consider the main theme of this book—should we merge with artificially intelligent machines, or risk being surpassed and becoming inconsequential or even extinct?

One significant impact that will be made by developments in enhancement technology and the emergence of machines with artificial intelligence will be on the law—specifically creating motivations for the passage of new laws and also discovering novel ways to use existing laws to apply in a human society intertwined with smart machines. The law can be found in Constitutions, statutes, government and industry regulations, and the judge-made decisions resulting from cases argued in court. When writing a law review article, the author is comforted when cases have been decided on the issue of interest. This is because the court will have heard the facts, examined the issues, listened to witnesses, and decided how the law applies. However, when dealing with the topic of cyborgs and artificially intelligent machines, we are just now at the stage where disputes are beginning to occur. For example, in 2012 Professor Steve Mann one of the first human-machine “cyborgs” living amongst us, was assaulted at a restaurant in Paris based on his appearance and technical capabilities as a cyborg. Since Steve has natural personhood status (a legal status granting him a range of rights), he could initiate a civil lawsuit on his own behalf (possibly for assault and battery). However, artificially intelligent machines have not yet reached a level of cognitive development to argue for personhood status, thus, they currently lack individual rights and the ability to defend their interests. But if in the future an artificially intelligent machine claimed to be sentient and subsequently argued for rights (at the time of this writing, it has been argued that an AI software bot posing as a teenage boy has passed the Turing test), the public should stay tuned, a tipping point would have been reached and it will get interesting.

To indicate the widespread interest in the topic of this book, let me briefly introduce some of the comments of renowned Cosmologist Sir Martin Rees, by conveying some of his highly interesting observations about our future—what some have termed the Post-Human era. Professor Rees rightly notes that there are chemical and metabolic limits to the size and processing power of organic brains which results in issues of bandwidth limitations and speed of information processing for humans. Furthermore, he notes that such limitations are not competitive with the raw processing power of computers and their march toward artificial general intelligence. But while some think that artificial intelligence is becoming our competition, prominent scientists such as Hans Moravec think of artificial intelligence as humanity’s natural future evolutionary path. Agreeing with Rees, I conclude that the potential for further development of artificial intelligence could

be as dramatic as the evolution from single-celled organisms to the humans that exist today. So, looking beyond the horizon, Rees eloquently states that “in the far future, it won’t be the minds of humans, but those of machines, that will most fully understand the cosmos—and it will be the actions of autonomous machines that will most drastically change our world, and perhaps what lies beyond.”

This book is about the technical, legal, and policy issues which are raised when humans and artificially intelligent machines are enhanced by technology. I discuss cyborgs, bionic humans, and machines with increasing levels of intelligence by linking a chain of fascinating subjects together—the technology of cognitive, motor, and sensory prosthetics; biological and technological enhancements to humans; and body hacking and brain–computer interfaces. Each of these technologies combines to tell the story of where we are going as a species, what policies to consider, and how the law and policy must adapt to accommodate the future of human-technology combinations. My goal in writing this book is to inform the public of what may be coming this century in terms of human cybernetic enhancements, artificially intelligent machines, and the development of cyborgs. I also aim to initiate debate among academicians on a range of scholarly topics, which often receive inadequate coverage in law and technology courses. In the coming decades, the decisions we make as a society, or more generally, as a species regarding how we enhance ourselves and create machines that may replace us, will affect the very essence of what it means to be human, nothing could be more compelling and important for humanity.

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