

## Chapter 2

# The Coming Singularity

If humans merge with machines this century, the coming Singularity will have a lot to say about that. What is the Singularity? The Singularity is that point in or development time when artificially intelligent machines equal or surpass humans in intelligence. The first use of the term “Singularity” was by the mathematician Jon von Neuman who in 1958 spoke of an ever accelerating progress of technology which would lead to changes in the mode of human life, thus giving the appearance that humanity was approaching some essential Singularity, beyond which human affairs, could not continue.<sup>1</sup> Twenty-five years later, science fiction writer Vernor Vinge coined the phrase “technological Singularity,” stating that “We will soon create intelligences greater than our own. When this happens, human history will have reached a kind of Singularity, an intellectual transition as impenetrable as the knotted space-time at the center of a black hole, and the world will pass far beyond our understanding.”<sup>2</sup> From a different perspective, Tim Wu, professor of law at Columbia University and author of “*The Master Switch*,” observed, “... make no mistake: we are now different creatures than we once were, evolving technologically rather than biologically, in directions we must hope are for the best.”<sup>3</sup> While Tim’s comment reflects the public’s current ambivalence about our cyborg future; I advocate for a different approach, one that involves the public educating themselves on the issues surrounding artificial intelligence and “cyborg technology,” and engaging in a rigorous debate about the future of humanity.

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<sup>1</sup>Technological Singularity, discussing the ideas Jon von Neuman’s and other contributors to the Singularity discussion, available at: [http://en.wikipedia.org/wiki/Technological\\_singularity](http://en.wikipedia.org/wiki/Technological_singularity).

<sup>2</sup>Vernon Vinge 1993 essay on the Singularity, available at: <http://mindstalk.net/vinge/vinge-sing.html>.

<sup>3</sup>Tom Wu, If a Time Traveller Saw a Smartphone, 2014, The New Yorker, at: <http://www.newyorker.com/tech/elements/if-a-time-traveller-saw-a-smartphone>; Tim Wu, 2011, *The Master Switch: The Rise and Fall of Information Empires*, Vintage Press.

Throughout this book, one of the key points I make is that we humans may be experiencing the last generation(s) of evolving predominately under the laws of biology. Why? Because as discussed in Kurzweil's "*The Singularity is Near: When Humans Transcend Biology*,"<sup>4</sup> an analysis of the history of technology shows that technological change is exponential. Kurzweil argues that exponential growth is contrary to the "intuitive linear" view most people have of societal progress in which we notice new technology entering our life, but are unaware of where we are in the curve representing the rate of change of technological advancements. According to Kurzweil, this means that we won't experience 100 years of progress in the twenty-first century—it will be more like 20 millennium of progress.<sup>5</sup> Thus, within a few decades, some argue that machine intelligence will surpass human intelligence, leading to the Singularity. The implications of which will include the merger of biological and nonbiological intelligence, immortal software-based humans, and ultra-high levels of intelligence that expand beyond our current imagination.<sup>6</sup>

The term "Singularity" has been applied to many different types of developments, but for this book the most common conceptualization of "the Singularity" is the idea of smarter-than-human artificial intelligence, the essence of which is software, machines, or robots that learn, reason, select their own goals, and evolve on their own. The concept for the Singularity goes something like this: many prominent researchers in artificial intelligence, robotics, and neuroscience are convinced that technology will eventually reach and then surpass humans in intelligence creating on the way, a world filled with 'smart' machines. Actually it's already happening. Machines that perform surgery, design life-saving drugs, write news articles, and work in a range of industries; in other words, do what we humans do with our mind and bodies, already exist. But once they surpass us in general intelligence, then what? Will they be content to continue performing the tasks asked of them by their human masters, or will they branch out from humans in terms of their goals and aspirations?

## Questions of Law and Policy

If the Singularity is to occur in the near future; there are critically important questions that society must address: should we merge with them (artificially intelligent machines), be surpassed by them, co-exist with them, enslave them, or risk being enslaved by them? And, as some have argued, for the survivability of the human race, should we decide to stop the Singularity before it has a chance to

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<sup>4</sup>Ray Kurzweil, 2006, *The Singularity is Near: When Humans Transcend Biology*, Penguin Books.

<sup>5</sup>*Id.*

<sup>6</sup>*Id.*

happen; or will it even be possible to stop the Singularity from occurring? While it may be comforting to avoid thinking about or answering these difficult questions, the never-ending march of technology towards the Singularity leaves us with no choice, we either get involved with determining the future of our species, or we passively observe as the future envelops us.

Considering the above possibilities, many forward thinkers predict that in the coming decades, we will merge with our silicon inventions. On the machine side, robotics expert Ray Kurzweil and Hans Moravec envision a time when tomorrow's machines will become more human-like, that is, appear in the form of an android and having super intelligence. On this point Berkeley physicist Max Tegmark writing in "*Our Mathematical Universe*," observed that the development of supercomputers with human or beyond levels of intelligence is likely, given that our brains are ultimately made of particles observing the laws of physics, and there's no physical law precluding particles from being arranged in ways that can perform even-more-advanced computations.<sup>7</sup> On the human side, 15 years ago in a book I co-edited on wearable computers I discussed human enhancement technology and the idea that humans would eventually merge with machines (the second edition is now available).<sup>8</sup> The merging of humans with machines could benefit humans in a number of ways: for example, by swapping our biology for non-biological parts we could gain the ability to automatically repair or replace prosthesis, including neuroprosthesis, when damaged or outdated. And instead of suffering from the effects of aging, we could age with more dignity, and possibly be able to turn the aging clock back. Due to the expected benefits, some commentators argue that the necessity for replacing and repairing human biology will enable society to view the merger of humans and intelligent machines as simply the next natural phase of evolution. Though the idea may seem extreme, especially for those unaware of the exponential growth of technology, many experts in robotics and computer science believe this is a likely scenario for our future. However, if we are to merge with machines we may have only a limited window of opportunity to do that; as once machines surpass us in intelligence, they may decide to continue evolving in ways incompatible with our goals and aspirations. They may conclude, why merge with a less intelligent species other than to gain access to their mobility, manual dexterity, or possibly their human emotions.

Technological advances in the first half of the twenty-first century in a wide range of fields such as robotics, neuroscience, artificial intelligence, sensors, nanotechnology, prosthetics, and material science, will lay the foundation for the Singularity to occur. According to those who argue that the Singularity is only a few decades away, beyond-human intelligence will result in self-directed or autonomous computers who will claim that they are sentient, and whose intelligence

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<sup>7</sup>Max Tegmark, 2015, *Our Mathematical Universe: My Quest for the Ultimate Nature of Reality*, Vintage Books.

<sup>8</sup>Woodrow Barfield (editor), 2015, *Fundamentals of Wearable Computers and Augmented Reality*, Second Edition, CRC Press.

and capabilities will increase exponentially rather than incrementally. Futurist Ray Kurzweil, a major voice arguing that the Singularity is close, puts the date of the Singularity at around 2045.<sup>9</sup> By then he estimates that the exponential increases in computing power resulting from Moore's law, along with advances in artificial intelligence will be sufficiently powerful enough to create beyond-human artificially intelligent machines. In this new world, Kurzweil believes there will be no clear distinction between human and machine or real reality and virtual reality. In practical terms, his prediction (with advances in nanotechnology) could mean the end of human aging and illness, pollution, world hunger and poverty. However, while the Singularity may be inevitable, which is a view I hold, there is serious debate as to when it will happen or even in the opinion of some researchers, if it will happen at all. For example, in 2011, one of Microsoft's founders, Paul Allen co-authored an article in the *MIT Technology Review* in which he took a more cautionary view of the coming Singularity than Kurzweil, arguing that while it is likely to occur, the timeframe will be the distant future.<sup>10</sup>

A strong voice against the idea that the Singularity will occur is Duke neuroscientist Miguel Nicolelis whose work on brain-computer interfaces is fascinating, but paradoxically in my view, is leading to a future human-machine merger.<sup>11</sup> Nicolelis' main argument is that "the brain is not computable and therefore no engineering can reproduce it."<sup>12</sup> Another problem he observes is that the brain is 'copy-write' protected by its own evolutionary history. However, describing his new Pattern Recognition Theory of Mind (PRTM), Ray Kurzweil voiced an opinion that couldn't be more different from Nicolelis— "We now have enough evidence to support a particular theory, a uniform theory about how the neocortex works".<sup>13</sup> According to Kurzweil, the neocortex is basically comprised of 300 million pattern recognizers which can wire themselves in hierarchies in relation to other pattern recognizers. The world is inherently hierarchical and the neocortex allows us to understand it in that hierarchical fashion. Regardless of whether or not the Singularity occurs, it's never too early for the public to consider the transformative effect the Singularity would have on humanity should it happen, and whether to embrace it or oppose it.

Considering that today's semiconductor manufacturers are adding more speed and memory into computers each year, leads some commentators to conclude that eventually our smart silicon creations will become efficient enough to build their own improved hardware and software models, increasing their intelligence and capabilities with each succeeding generation. Thinking about policy and law, if

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<sup>9</sup>Kurzweil, *id.*, note 4.

<sup>10</sup>Paul G. Allen and Mark Greaves, 2011, *The Singularity Isn't Near*, MIT Technology Review.

<sup>11</sup>Miguel Nicolelis, 2013, *The Brain is Not Computable*, MIT Technology Review.

<sup>12</sup>*Id.*

<sup>13</sup>Ray Kurzweil, 2013, *How to Create a Mind: The Secret of Human Thought Revealed*, Penguin Books.

a machine with artificial intelligence could generate its own code, heuristics, and algorithms, would the artificial intelligence or human (manufacturer, owner, 3rd party) be responsible for its actions? Current legal paradigms are poorly equipped to answer this question, yet it is a critical one to address. The main point to make is this: intelligent and autonomous machines engaging in “human activities,” will challenge current legal paradigms and will result in a host of issues. For example, will a contract negotiated by an artificially intelligent machine be considered valid, who will be considered the contracting parties, and who will be responsible for a breach of contract? The field of electronic commerce is grappling with just this issue as intelligent software agents with increasing intelligence and autonomy roam the internet and engage in contract negotiations. To take this point one step further every enforceable contract has an offer and acceptance, consideration, and an intention to create legal obligations. At present, an artificially intelligent machine is not viewed as having the ability to form an intention on its own volition and thus for this and other reasons cannot contract on its own behalf.

What are some “legal relationships” formed between humans and machines? Considering humans and artificially intelligent machines, there is established law that applies to situations where one party allows another to negotiate on its behalf—the law of agency. Generally, the law of agency is an area of commercial law dealing with a set of legal (typically fiduciary) relationships that involve a person or software entity, called the agent, that is authorized to act on behalf of another, called the principal, to create legal relations with a third party. The agent owes the principal a number of duties such as: a duty to undertake the task or tasks specified by the terms of the agency (that is, the agent must not do things that he has not been authorized by the principal to do); a duty to discharge his duties with care and due diligence; and a duty to avoid conflict of interest between the interests of the principal and his own (that is, the agent cannot engage in conduct where s/he stands to gain a benefit for himself to the detriment of the principal).<sup>14</sup> If it is subsequently found that the alleged agent was acting without necessary authority, the agent will generally be held liable. Since software agents can bind the principle in contract, it seems likely that future artificially intelligent machines will also be able to serve as agents and as a consequence, be subject to agency law.<sup>15</sup>

In the field of criminal law, we have created a legal system in which the victim is human, but what if the “victim” is an artificially intelligent machine claiming that it has rights? For example, what if a software virus is uploaded onto the operating system of an artificially intelligent machine? What rights does the machine have to protect the integrity of its software, the machine’s equivalent of the humans prefrontal cortex or limbic system? One outcome is entirely likely, the cycle of improvement of technology will continue to evolve into what many have described as an intelligence explosion. Artificially intelligent machines could

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<sup>14</sup>Roderick Munday, 2013, *Agency: Law and Principles*, Oxford University Press.

<sup>15</sup>See Generally, Ronald Mann and Jane Winn, 2004, *Electronic Commerce*, Aspen Law and Business.

**Fig. 2.1** X-ray image of implanted technology for hearing. (Image courtesy of Michael Chorost)



then keep on developing until they far surpass human levels of intelligence. The Singularity will also speed other technology breakthroughs; in fact, some have argued that the future may advance so quickly, that at some point, our biological brains, if not enhanced, will no longer be able to understand the direction of machine evolution (Fig. 2.1).

As a consequence, a number of scientists and philosophers worry that artificial intelligence may someday make humanity superfluous; however, a positive post-Singularity world could include affordable healthcare (but healthcare itself could be vastly different), providing most world citizens with indefinite lifespans, and a global economy strong enough to erase today's gap between the rich and poor. And here's what stimulates the imagination of those who believe that the Singularity is near; the possibility to have lived long enough to benefit from the amazing technologies that the Singularity will usher in. Ray Kurzweil in his book *Fantastic Voyage, Live Long Enough to Live Forever*, agrees saying that advances in stem cells, genetics, and nanomedicine expected during the next couple of decades, could stave off deadly diseases; bringing many of us into this high-tech world of tomorrow; that is, if we live long enough to become cyborgs and merge with machines.<sup>16</sup> Whatever we call those who move beyond traditional notions of human-ness, their decision to go posthuman will have legal, moral, philosophical, social, and political implications.

## Towards Machine Sentience

Researchers, science fiction authors, and the media who write about the Singularity, often focus on artificial intelligence as the key technology. On the topic of machine intelligence, Curtis Karnow, Judge on the California Superior

<sup>16</sup>Ray Kurzweil, 2005, *Fantastic Voyage, Live Long Enough to Live Forever*, Plume Books.

Court, and author of *“Future Codes: Essays in Advanced Computer Technology and Law,”* frames intelligence in terms of machine autonomy; autonomy being the ability of the machine to program itself to solve problems independent of a human.<sup>17</sup> The more the machine can make real time decisions in unpredictable environments, the greater the machine intelligence. I use a broader definition of intelligence; when I use the term, I mean to describe artificially intelligent machines which have the capability to perform cognitive, perceptual, and motor tasks at human levels of skill. Thus, a computer that could accurately diagnose disease would be considered intelligent in that domain, as would a computer that could write original short stories, compose music, or manage a hedge fund. A numerically controlled industrial robot, repetitiously moving in predetermined positions, would obviously be considered far less intelligent.

With the exception of the industrial robot, notice that the examples I just mentioned are very “cognitive-oriented;” but other areas of human performance also represent clear examples of intelligent behavior by computing machines. For example, new generations of robots can keep their balance as they navigate difficult terrain or walk up stairs. And the senses of our intelligent inventions are getting better and smarter; including automobiles equipped with algorithms, computer vision, GPS, and limited forms of artificial intelligence. But impressive as the recent gains in artificial intelligence have been, in my view, the discussion of intelligence and the Singularity misses an important point. Even though “intelligence” is used as the key factor in discussions of the coming Singularity, I think the more important issue for humanity to consider, is that of “sentience,” that point in time or development when artificially intelligent machine claims to be conscious and alive. When that happens, and I believe it will by the end of this century, it will get interesting. I for one would have no problem pulling the plug on a machine smarter than me, but clearly not conscious; whereas, I would have difficulty pulling the plug on a machine that convinces me it is conscious and not a threat to humanity. At this basic level, this question of ethics boils down to the debate we humans engage in about the death penalty.

There are numerous techniques being explored to create artificial intelligence, and eventually a sentient mind, raising important questions of law and policy. One of the early pioneers in the field of genetic algorithms, University of Michigan’s John Holland, has used principles of biological evolution, to show that computers could “evolve” their programming to solve complex problems in ways that even their creators did not fully understand.<sup>18</sup> According to Judge Karnow, lacking the status of legal entities, once computers solve problems in ways not anticipated by the programmer, many areas of current law lack the appropriate legal tests to account for their actions. This is not only an issue of law, but of public policy, as

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<sup>17</sup>Curtis Karnow, 1997, *Future Codes: Essays in Advanced Computer Technology and Law*, Artech House Publishers.

<sup>18</sup>John Holland, 1992, *Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence*, A Bradford Book.



the relationship between humans and our intelligent inventions should be discussed in a free and open debate by an informed public. Professor Holland concludes that for machine sentience to occur, in the final analysis, hardware is just a way of executing programs, for sentience it's the software and algorithms that count. This point was also made by Professor Max Tegmark,<sup>19</sup> who commented that our first ultra-intelligent machine once invented will be severely limited by its software, but that once the machine can rewrite its own software, then this evolving machine could soar above the intelligence of humans in a matter of hours. I couldn't agree more, for artificially intelligent machines to reach the Singularity, and to become sentient, significant advances will have to be made in our understanding of the human brain's capacity to compute, and this knowledge will need to be embedded into algorithms and heuristics, that are etched on chips and written as software for thinking machines.

Currently, thousands of researchers around the world are working on just this goal, and in the last 10 years more has been learned about how the brain processes information and makes sense of the world than in the preceding history of neuroscience. Even so, it is always pertinent to point out the opposing view. For example, Duke University neuroscientist, Miguel Nicholas,<sup>20</sup> a pioneer in brain-computer interfaces, has argued that human thought will never emerge from silicon. When I consider the work being done in artificial intelligence, robotics, and neuroscience, I can't help but think that the work by Nicholas to create brain-computer interfaces, is not only innovative but another piece in the puzzle to create a post-human future in which humans merge with machines. Writing with computer scientist Mark Greaves, Paul Allen<sup>21</sup> cofounder of Microsoft, observed that "The amazing intricacy of human cognition should serve as a caution to those who claim the Singularity is close."<sup>22</sup> Allen also commented that "Without having a scientifically deep understanding of cognition, we can't create the software that could spark the Singularity."<sup>23</sup> One of the most ardent opponents of the idea that a computer can reach sentience is physicist Roger Penrose. In "*The Emperor's New Mind*" Penrose argued against the idea that intelligence or consciousness could emerge in a machine based on a sufficient number of algorithms.<sup>24</sup> Penrose observed that there are aspects of intelligence and consciousness that are intrinsically non-algorithmic. When taking Penrose's criticism into account, we should note that the critique was written in the 1980s (about 20 doublings in computing power ago); and these days we now believe that there are other avenues to artificial

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<sup>19</sup>Max Tegmark, *id.*, note 7.

<sup>20</sup>Miguel Nicholas, *id.*, at note 11.

<sup>21</sup>Paul Allen, *id.*, note 10.

<sup>22</sup>Paul Allen, *id.*, note 10.

<sup>23</sup>Paul Allen, *id.*, note 10.

<sup>24</sup>Roger Penrose, 2002, *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*, Oxford Paperbacks.



intelligence than traditional algorithmic programming. When Penrose wrote his criticism, little was then known about the power of neural networks, or behavior-based robotics with the ability to learn by observation and trial-and-error and no microchips were being designed to mimic how the brain processes information. Whether these tools and one's to be developed will be sufficient to reach the Singularity, stay tuned, we will likely find out in the next few decades.

In my view, unlocking the mysteries of the human brain is a necessary requirement for the Singularity to occur and for machines to become sentient. A preview of what may be possible in modeling and replicating the brain is visible in the sequencing of the human genome. In *"How to Create a Mind,"* Kurzweil notes that every year since the human genome project began in 2001, the amount of genetic data sequenced has doubled; he expects similar progress to occur in neuroscience and artificial intelligence.<sup>25</sup> To jump-start progress in brain science, the European Union, the U.S., and other countries are funding major initiatives to make this happen. Within the European Union, Henry Markram and others at the Swiss Federal Institute of Technology, is using the power of supercomputers to analyze the principles behind the brain's processing. The approach is that, if we understand the architecture of thinking, we can build a system that emulates it. Beyond that, Markram's neuroscience project aims at "reconstructing the brain piece by piece and building a virtual brain in a super computer," making possible artificial intelligence systems that can bootstrap their way to ever-greater powers of thinking and planning.<sup>26</sup> Similarly, in the U.S., the *Brain Research Through Advancing Innovative Neurotechnologies Initiative*, is a program whose goal is to likewise accelerate our understanding of the human brain. By accelerating the development and application of innovative technologies, researchers will be able to produce a dynamic picture of the brain that will show how individual cells and complex neural circuits interact in both time and space.<sup>27</sup> This picture will fill major gaps in our current knowledge of neuroscience and provide unprecedented opportunities for exploring how the brain enables the human body to record, process, utilize, store, and retrieve vast quantities of information, all at the speed of thought.<sup>28</sup> The findings of this research will be extremely useful for developing artificial intelligence that emulates how the human brain performs cognition. Clearly, such research will set the stage for a future human-machine merger.

To create machines that can think, researchers are trying to build a computer that has some—and preferably all—of three characteristics that brains have and current computers do not. These are: low power consumption (human brains use

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<sup>25</sup>Ray Kurzweil, *id.*, notes 13, 16.

<sup>26</sup>The Human Brain Project, reconstructing the brain piece by piece and building a virtual brain in a supercomputer, at: <http://aminotes.tumblr.com/post/13213154066/the-human-brain-project-reconstructing-the-brain>.

<sup>27</sup>Brain Research through Advancing Innovative Neurotechnologies<sup>SM</sup> (BRAIN), at: <http://braininitiative.nih.gov/>.

<sup>28</sup>*Id.*

about 20 W, whereas the super computers used to try to simulate them need megawatts); fault tolerance (losing just one transistor can wreak havoc on a microprocessor, but brains are plastic and lose neurons all the time); and a lack of need to be programmed (brains learn and change spontaneously as they interact with the world, instead of following the fixed paths and branches of a predetermined algorithm).<sup>29</sup> One technology to meet these objectives is the use of neuromorphic chips that actually require no lines of programming code to function. Instead, researchers report that the chip learns in the way “real brains” do. From a computer architecture perspective, an important property of a real brain is that it operates like a small-world network. Each neuron within such networks can have thousands of synaptic connections with other neurons. This means that, even though a human brain contains about 85–100 billion neurons, each is within two or three connections of all the others via myriad potential routes. In both natural brains and many attempts to make artificial ones, memory formation involves strengthening some of these synaptic connections and pruning others. It is this observation that allows the neuromorphic chips to process information without having to rely on a conventional computer program.

The more we learn about the architecture of the brain, the closer we are to building a computer to emulate it. For example, as Kurzweil observes the neocortex, where most neurons reside and which accounts for three-quarters of the brain’s volume, is made up of lots of columns, each of which contains about 70,000 neurons.<sup>30</sup> The neuromorphic chips being built to emulate the brain, are equivalents of cortical columns, connecting them up to produce a computer that is, in this particular at least, truly brain like. There remains, of course, the question of where neuromorphic computing might lead. At the moment, it is primitive. But if the technique succeeds, it may allow the construction of machines as intelligent as—or even more intelligent than—human beings.<sup>31</sup> Human beings like to think of their brains as more complex than those of lesser beings—and they are. The main difference between a human brain and that of an ape or monkey is of organization and wiring.<sup>32</sup> It really might, therefore, simply be a question of linking enough appropriate components up and letting them organize themselves to create a conscious machine. And if that works perhaps, as Marvin Minsky, a cofounder of the field of artificial intelligence put it, “they” will keep humanity as pets.<sup>33</sup>

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<sup>29</sup>Neuromorphic Computing, *The Machine of a New Soul*, 2013, *The Economist*. Online pdf file.

<sup>30</sup>Ray Kurzweil, *id.*, notes 13, 16.

<sup>31</sup>Neuromorphic computing: The machine of a new soul; Computers will help people to understand brains better. And understanding brains will help people to build better computers, at: <http://bambooinnovator.com/2013/08/02/neuromorphic-computing-the-machine-of-a-new-soul-computers-will-help-people-to-understand-brains-better-and-understanding-brains-will-help-people-to-build-better-computers/>.

<sup>32</sup>*Id.*

<sup>33</sup>Can Machines Think, some interesting discussions on this topic by AI pioneer, Marvin Minsky, available at: <http://psych.utoronto.ca/users/reingold/courses/ai/think.html>.

Industry is also heavily involved in developing artificial intelligence. For example, Google has been on a spending spree acquiring companies developing machine-learning and robotics, including Boston Dynamics, a firm that produces life-like military robots; smart thermostat maker Nest Labs; Bot and Dolly; Meka Robotics, Holomni; Redwood Robotics; Schaft; and another AI startup, DNNresearch. Further, Google recently purchased *DeepMind*, a company on the cutting edge of artificial intelligence research. The “Deep” in DeepMind refers to techniques which allow computers to learn patterns from different forms of data and images without being specifically programmed to do so.<sup>34</sup> Taking inspiration from the way neurons work in the human brain, “deep learning” uses layers of algorithms that successively recognize increasingly complex features, going from, say, edges to circles to a chair in an image. Such a technique seems well suited to the current generation of supercomputers that can perform trillions of operations per second.

## Telepathy, Brain Nets, and Cyborgs

Traditional law and public policy was founded on a distinction between human beings and machines (as well as animals), but nowadays technology is beginning to blur this distinction and cyborgs, which are the fusion of humans and machines, need to be included in discussions of who deserves legal rights. Later this century, the issue of determining who should receive rights, will again be relevant (and will need to be revisited) when artificially intelligent machines argue they are alive. While not currently considered a cyborg in legal jurisdictions (what would the particular rights associated with a cyborg be?), the experiences of Steve Mann, a person who has been wearing computers for decades, is illustrative of how society and the law might deal with the accelerating trend of human-machine evolution. Steve’s personal experience as a cyborg wearing head-mounted display technology to view and mediate the world, has resulted in disputes with government agencies and corporations. For example, as noted in Chap. 1, before boarding a Toronto-bound plane at St. John’s International Airport in Newfoundland, Steve’s “cyborg” appearance garnered scrutiny and he was searched and reportedly injured by security personnel.<sup>35</sup> Another self-reported cyborg, Neil Harbisson, who has an implanted chip interfacing with a head-mounted sensor, has also experienced difficulty at airport security. But Neil travels with his passport, which includes his picture with the head-worn technology. On the one hand, security is an important issue at airports especially post 9–11, but what about the rights of a person

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<sup>34</sup>Thomas Halleck, 2014, What Is DeepMind? The Artificial Intelligence Firm Bought By Google, at: <http://www.ibtimes.com/what-deepmind-artificial-intelligence-firm-bought-google-1549126>.

<sup>35</sup>Lisa Guernsey, At Airport Gate, a Cyborg Unplugged, NY Times, available at: <http://www.nytimes.com/2002/03/14/technology/at-airport-gate-a-cyborg-unplugged.html>.

wearing computing technology that serves a valid and critical function, and can't be easily removed from their body? From Steve's perspective, the question of how a traveler will fare once wearable computing devices are fixtures on their body, leads him to postulate, "We have to make sure we don't become a police state where travel becomes impossible for certain individuals."<sup>36</sup> Steve has a valid point, the right to travel without restrictions is a fundamental right under most constitutions; therefore, we must create policy that balances the need for security against the rights of cyborgs, and in the future artificially intelligent machines that are sentient, to travel as freely as any natural person.

This area of "cyborgization" is not without scrutiny from the government. In an attempt to address the issue of people equipped with prosthesis going through airport security, the U.S. TSA has developed some guidelines to accommodate travelers with medical devices and disabilities. For example, such travelers have the option to be screened without removing their prosthetic, but in this case they must inform the TSA officer that they have a prosthetic device before screening begins. And rather than verbally informing the TSA officer of their prosthetic, they have the option of downloading a notification card from the TSA website which can be shown to the agent. A person with a prosthetic can also be screened by a metal detector, can be patdown, or examined by imaging technology while still wearing the prosthetic device. But they also have the option to remove their prosthetic and have the device X-ray screened. However, whatever the procedure the cyborg uses, their prosthetic will still receive additional screening, the officer will request to see the prosthetic, and will test the prosthetic for explosive residue with the appropriate scanner. It seems clear that the more the prosthetic is actually embedded into the body, the more difficult, if not impossible, it will be for airport security to scan the device, for the device to be removed, and for cyborgs to travel freely using commercial airplanes without restrictions.

Like Steve, other cyborgs are gradually working their way into our lives and leading humanity toward the Singularity. Consider Neil Harbisson<sup>37</sup> discussed above, who was born color-blind and now wears an electronic eye that renders color as sound; how will airport security scan this device? Then there's Michael Chorost, author of "*Rebuilt: How Becoming a Computer Made Me More Human.*" Michael was born with impaired hearing and became completely deaf in 2001; he now has a computer implanted in his head which allows him to hear again. As a cyborg, his experience with the world, is dependent on the CPU speed of his implanted computer; which unlike the human brain, can be updated.

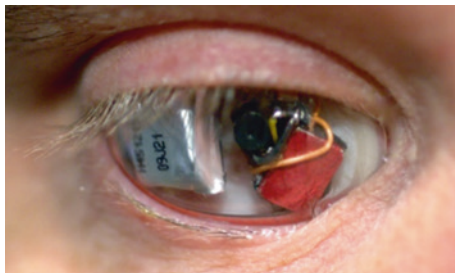
Necessity is the mother of invention, and likewise, accidents create cyborgs. After crashing on a motorcycle, Jerry Jalava<sup>38</sup> lost a finger, and being tech savvy, he

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<sup>36</sup>*Id.*

<sup>37</sup>Neil Harbisson, The Man Who Hears Colour, BBC News, at: <http://www.bbc.com/news/technology-29992577>.

<sup>38</sup>Justin Yu, USB Prosthetic Finger Gives New Meaning to Thumbdrives, available at: <http://www.cnet.com/news/usb-prosthetic-finger-gives-new-meaning-to-thumbdrives/>.



**Fig. 2.2** The Eyeborg Project began when one-eyed filmmaker, Rob Spence decided he wanted a prosthetic eye with a video camera in it. The device contains a miniature camera and micro RF transmitter that can send out what Rob's eyecam sees to a receiver and beyond. (Image Courtesy of Rob Spence)

embedded a 2 GB USB drive in the tip of his prosthetic finger, essentially converting his finger into a hard drive. At this time, the USB drive isn't permanently fused to his finger, instead, it's inside a rubber tip that fits onto the nub of his prosthetic finger. Eventually, however, he's hoping to upgrade it to a more truly bionic connection. And then there's Canadian filmmaker Rob Spence, whose loss of vision was the determining factor for converting him into a cyborg (Fig. 2.2). After a shooting accident left him partially blind, he decided to create his own electronic eye, and he now calls himself an Eyeborg.<sup>39</sup> Not only can he record everything he sees just by looking around, but the system could allow another person to access his video feed and view the world through his right eye. Says Spence, "Unlike you humans, I can continue to upgrade," "Yes, I'm a cyborg."<sup>40</sup>

One of the most significant developments in technology that is leading the way towards humans merging with artificially intelligent machines is the progress being made in brain-computer interfaces. In fact, a direct interface between the brain and the Internet has been successfully tested in laboratory experiments and for people who suffer from debilitating neurological disease. Research in brain-computer interfaces is interesting from another point-of-view, it may lead to direct mind-to-mind communication. This brings up the possibility of telepathy, a technology which would allow brain-to-brain communication and brain-to-AI communication. Seminal work on brain-to-brain interfaces, has been done by researchers at Duke University Medical Center and Kevin Warwick at the University of Reading in the UK. But before moving on to their studies, let's discuss an actual court case. In 1993, Teri Smith Tyler<sup>41</sup> filed a federal lawsuit against, among

<sup>39</sup>Eyeborg Project, at: <http://eyeborgproject.com/>.

<sup>40</sup>Tom Hornyak, 2010, Eyeborg: Man Replaces False Eye with Bionic Camera, at: <http://spectrum.ieee.org/automaton/biomedical/bionics/061110-eyeborg-bionic-eye>.

<sup>41</sup>*Tyler v. Carter*, 151 F.R.D. 537 (S.D.N.Y. 1993). Plaintiff-Cyborg, available at: <http://home.pacifier.com/~dkossy/tyler.html>.

others, William Clinton, Ross Perot, the Defense Intelligence Agency, IBM, David Rockefeller, and NASA, alleging, and here's where it gets interesting, a bizarre conspiracy involving the defendant's effort to enslave and oppress certain segments of our society. Teri contended she was a cyborg, and that she received most of the information which formed the basis for her complaint, through "proteus," via a silent, telepathic form of communication. The case of course was dismissed as frivolous but still, given advances in brain-computer interface technology, how far off are we from a case featuring telepathy and an implanted sensor that has actual merit?

In a remarkable breakthrough for people paralyzed from spinal cord injuries, brain implant technology has allowed a person with a severed spine to move again. How does the technology work? Generally, the technology bypasses the patient's severed spine by sending a signal from the brain directly to metal bands placed on the patient's muscles. In the procedure, first, the surgeons map the exact spot in the patient's motor cortex that control the muscles in a particular part of the body, then they implant a tiny computer chip at that location. The next step is to "teach the chip" how to read the patient's thoughts. This is done by placing the patient inside an MRI machine, where the patient watches a video of a hand moving in specific ways and at the same time imagines moving his own hand that way. The implanted chip reads the brain signals, decodes them, and translates them into electrical signals where they are transmitted to the muscles of the patient's forearm. Next, the patient is "plugged into" technology, by running a cable from his skull to his arm, connecting the implanted chip to the metal bands on his arm. When the patient focuses his mind on moving his hand, it moves. This experimental and developing technology, still has a long way to go before it will become common treatment for paralyzed patients; for example, it needs to be wireless so there is not a cable plugged into the skull and researchers need to figure out a way to send a signal from the body back to the brain so the patient can sense when his body is moving.

Leading the way towards a cyborg future, Duke neurobiologist Miguel Nicolelis and his colleagues have reported the successful wiring together of sensory areas in the brains of two rats.<sup>42</sup> Remarkably, they discovered that one rat will respond to the experiences to which the other is exposed. The fascinating question they asked was this- could the brain of one animal assimilate information input from sensors from a different body? Without going into the details of their study, they found evidence that brain-to-brain communication was possible. Having shown the feasibility of direct brain-to-brain communication, the Duke University group is now pushing forward with additional studies, most notably by trying to interconnect several rat brains at once. Could an emergent "brain-net" develop, perhaps leading to mental abilities not possessed by any one brain? Whatever the future holds, what has already been accomplished is worth a certain amount of wonder. Imagine what it might feel like to be a unit in a multiform brain having

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<sup>42</sup>Miguel Nicolelis, 2012, *Beyond Boundaries: The New Neuroscience of Connecting Brains with Machines—and How It Will Change Our Lives*, St. Martin's Griffin.

many bodies; say all Oxford University students connected to the same brain net, all IMB employees connected to the same brain net, all family members connected to the same brain net, you get the picture. The benefits and potential dangers of such networks deserves contemplation. However, not everyone is enthusiastic about the possibility that people's brains may be collectively networked. For example, Rob Spence,<sup>43</sup> the Eyeborg, pondered, "In today's world, you have Facebook and camera eyes," "Tomorrow, we'll have collective consciousness and the Borg. It's a collective robot consciousness. I believe that's a genuine modern concern."<sup>44</sup>

Still, the idea of connecting people together by means of technology, is moving forward on several fronts. For example, as discussed in Chap. 1, Professor Kevin Warwick and his wife, both had silicon chips surgically connected to nerve fibers in their arms just above the elbow. Each chip had a power source, a tuner and a radio transceiver. The goal of their proof-of-concept study was to create a form of telepathy using the Internet to communicate signals between the two. The prototype resulted in the first direct and purely electronic communication between the nervous systems (not brains) of two humans. Interestingly, Warwick's wife commented that she did not want her husband to be "linked up to another woman." The law side of my brain can't help but wonder what marriage and divorce law will look like in the cyborg future?

The ability for telepathy, combined with a host of technologies which may be used to read one's mind, brings up many critical issues of law and policy as we near the Singularity. For example, technology may soon allow a person's brain to be scanned to determine their thoughts. How will this affect fundamental rights to privacy? If a person's home is their castle, is a person's mind deserving of any less protection? We have to wonder, are existing constitutional protections sufficient to protect our freedom of thought as we merge with machines? If telepathy becomes possible, the government's ability to intercept and read thoughts transmitted with wireless communication technology, will be far easier than reading electro-chemical thoughts produced by biological brains—thus it would be prudent to consider all the ramifications of brain-computer interfaces as we move towards merging with machines. On this point, Duke University Law Professor, Nita Farahany, provided an ominous warning stating, "We have this idea of privacy that includes the space around our thoughts, which we only share with people we want to."<sup>45</sup> "Neuroscience shows that what we thought of as this zone of privacy can be breached."<sup>46</sup> Under the U.S. Constitution, the Fourth and Fifth Amendments respectively protect against unreasonable searches and seizures; and self-incrimination, which forbids the state from turning any citizen into "a witness against

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<sup>43</sup>Eyeborg, at: <http://eyeborgproject.com/team/>.

<sup>44</sup>*Id.*

<sup>45</sup>Nita A. Farahany, *Incriminating Thoughts*, 64 *Stanford Law Review*, 351–408 (2012).

<sup>46</sup>*Id.*



himself.”<sup>47</sup> Farahany asks- will “taking the Fifth and thus refusing to provide information that may incriminate oneself” mean anything in a world where the government can scan your brain?<sup>48</sup> On this point, I wonder if in the future, the government will have the technology to search the prefrontal cortex of any citizen. If done without a search warrant, then a major constitutional right would have been lost.

Given the significant developments unfolding in the world of brain-computer interfaces, from a cybersecurity perspective, I anticipate a wide variety of potential criminal and terrorist threats to the human brain, and for that matter, to any artificial intelligent brain, conscious or not. Why think that? First, the technology already exists to attack neural devices. In fact, the media has already published stories about the possibility of hacking pacemakers and other medical devices and the FDA is moving to regulate in this area.<sup>49</sup> With the same technology hackers could attack devices implanted within the human body, including wireless devices, controllers for prosthetic limbs, or deep brain stimulators. Second, people have the means and the motivation to exploit neural devices.<sup>50</sup> And third, the track record of the use of computers and the Internet shows that people, governments, and crime organizations will attack and subvert computers and devices if given a reason to do so.<sup>51</sup>

The threat to neural devices is even more serious than the threat to computers and the Internet. Conventional attacks to computers and the Internet typically affect money, data, and other property; but none of these consequences directly affect the human body. However, the hacking of medical devices could result in immediate death or injury to a person with wirelessly connected implants. And the use of neural devices entails an even greater risk because attacking a neural device may have the effect of wiping out some or most of someone’s memory or even corrupting the thought processes. What could be a more basic human right than to protect your mind from outside interference? I think that once the Singularity is reached and artificial intelligence claims to be sentient, hacking its software and prosthesis may too result in unacceptable harm to an entity deserving self-preservation.

And what about thoughts implanted in your mind against your will, or your internal thoughts recorded by a neurochip supplied by a corporation, possibly under a license agreement? Who then owns the copyright to your thoughts? This scenario is not going to be litigated anytime soon, but we may be headed there eventually.

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<sup>47</sup>*Id.*

<sup>48</sup>*Id.*

<sup>49</sup>Stephen S. Wu and Marc Goodman, SCIENCE AND TECHNOLOGY LAW: Neural Implants and Their Legal Implications, at: [http://www.americanbar.org/publications/gp\\_solo/2013/january\\_february/science\\_technology\\_law\\_neural\\_implants\\_legal\\_implications.html](http://www.americanbar.org/publications/gp_solo/2013/january_february/science_technology_law_neural_implants_legal_implications.html).

<sup>50</sup>*Id.*

<sup>51</sup>*Id.*

Just consider the patent filed by Sony (U.S. patent 6,536,440)<sup>52</sup> which describes a technique to use ultrasound to influence and manipulate nerve impulses in the brain thus allowing sensory data to be projected onto the human neural cortex. The technique suggested in the patent is entirely non-invasive as it uses a device that fires pulses of ultrasound at the head to modify firing patterns in targeted parts of the brain, creating ‘sensory experiences’ ranging from moving images to tastes and sounds. While the technology could give blind or deaf people the chance to see or hear, the technology raises the interesting question of whether the thoughts produced by people using the technology could be copyrighted by Sony.<sup>53</sup>

## Bodily Integrity

As humans become enhanced with technology, and as artificially intelligent machines become more human-like, I believe the issue of bodily integrity will become an important topic for the law and for policy makers to consider. Perhaps androids will be particularly interested in protecting the integrity of their body out of vanity. Interestingly, their appearance could be protected under copyright law or the right of publicity; which is implicated if an android takes on the image of a celebrity (see Chap. 7: *The Law of Looks and Artificially Intelligent Brains*). Vanity, or computers experiencing other emotions is not some far-off possibility, instead it’s already here, albeit in a limited manner. As early as 2000, Professor Rosalind Picard, of MIT’s Media Lab, and author of “*Affective Computing*,”<sup>54</sup> noted that the human brain, which, of course, is a critical part of our ability to see and perceive, is not entirely logical, but emotional as well. Therefore, she concluded for computers to have some of the advanced abilities we desire, it may be necessary that they comprehend and, in some cases, feel emotions. On the simplest level, this may mean installing sensors and programming that allow a computerized system to determine the emotional state of its user and respond accordingly, on a more advanced level, it may mean “giving” the artificial intelligence emotions. Once an artificially intelligent machine, such as an android or robot, experiences emotions, and feels a connection to their body, they may be concerned with how others perceive them. They may even argue for the right to receive technological enhancements, including digital cosmetic enhancements, which may serve no functional purpose whatsoever.

Cyborgs and artificially intelligent machines may have reason to be concerned about human reaction to them, just consider the phenomena of the “uncanny valley” (see Chap. 7). This concept, originally intended to provide an insight into

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<sup>52</sup>Sony Patent 6,536,440, Method and System for Generating Sensory Data onto the Human Neural Cortex.

<sup>53</sup>See generally, *id.*

<sup>54</sup>Rosalind Picard, 2000, *Affective Computing*, MIT Press.

human reactions to robotic design, can also be extended to human interactions with nearly any nonhuman entity. Stated simply, the idea is that humans react favorably to a “human-like” machine, but only to a particular point. For example, humans generally like the appearance of robotic toys, but once a robot is designed to look like a human, and doesn’t quite meet the standard, people report a strong negative response to its appearance. However, once the appearance is indistinguishable from a human, the response becomes positive. So the response goes... positive, negative, then positive again. This chasm, the uncanny valley, represents the point at which a person observing the creature or object in question sees something that is nearly human, but just enough off-kilter to seem eerie or disquieting.<sup>55</sup>

Generally, body integrity is concerned with the inviolability of the physical body and emphasizes the importance of personal autonomy and the self-determination of human beings over the fate of their own bodies. In most societies the violation of bodily integrity is considered an unethical infringement; and in most legal jurisdictions, a criminal intrusion of the body. As we humans become equipped with more technological enhancements, the issue of body integrity will involve not just our biological parts, but our prosthesis and other cyborg technologies. Interestingly, there are a very small percentage of people who request that a normal limb be amputated; and some people have actually had unnecessary amputations performed. In this case, a person’s idea of how they should look does not match how they actually do look; to me this represents an example of the uncanny valley. Such people are diagnosed as having “Body Integrity Identity Disorder.”<sup>56</sup> The main idea behind this disorder is that it occurs when the brain views the “offending limb” as being foreign and not actually a part of the person, resulting in a strong desire to have it removed. A corollary for cyborgs is that the matching of parts to the person’s body must be done in such way as to reinforce acceptance of the technology.

Could the rejection of prosthesis serve as an issue for the coming Singularity? Research on people’s acceptance of prosthesis has indicated that in some cases the acceptance rate is generally low.<sup>57</sup> The factors for the low acceptance typically cited include the functional capabilities of the prosthesis and technical difficulties, such as malfunctioning joints and poor fitting to the residual limb. Acceptance of cyborg technology or not, defective prosthesis result in lawsuits under the theory of Products Liability. For example, due to the aging population in the U.S., and other western nations, the past decade has seen a striking increase in hip and knee

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<sup>55</sup>An Uncanny Mind: Masahiro Mori on the Uncanny Valley and Beyond, IEEE Spectrum, 12 June 2012.

<sup>56</sup>David J. Brang, Peter Brugger, Michael First, Uwe Gieler, Amra Hodzic Arjan W. Braam, 2009, Body Integrity Identity Disorder: Psychological, Neurobiological, Ethical and Legal Aspects, Pabst, Wolfgang Science.

<sup>57</sup>Stephen F. Burrough, Judith A. Brook, Patterns of Acceptance and Rejection of Upper Limb Prostheses, Digital Resource Foundation, at: [http://www.oandplibrary.org/op/1985\\_02\\_040.asp](http://www.oandplibrary.org/op/1985_02_040.asp).

replacements and with it, hip and knee replacement failures and lawsuits to recover damages. Further, many examples of products liability cases dealing with prosthesis involve defective heart defibrillators. In this case, patients often face the risk of having a potentially defective heart device removed and replaced and the risk of infection resulting from the surgery to remove the device. For one manufacturer of heart defibrillators, many patients and their doctors are weighing these competing risks as a result of a FDA decision to recall thousands of defibrillators that can potentially short-circuit when they are needed. Defibrillators emit an electrical jolt to restore rhythm to a chaotically beating heart. It is not uncommon for medical devices already implanted in people—products like artificial hips, breast implants and pacemakers—to be recalled. Such recalls reflect an acknowledgment by a company and the FDA that a device poses either a new type of risk or an increased level of a known one.

For humans, bodily integrity is an issue that has been addressed in numerous international jurisdictions. For example, the Constitution of Ireland mandates that “you have the right not to have your body or personhood interfered with.”<sup>58</sup> This means that the State may not do anything to harm a person’s life or health. In the U.S., the Federal Constitution does not contain any specific provisions regarding the rights one has with respect to his or her physical body or the specific extent to which the state can act upon bodies. However, the U.S. Supreme Court has upheld rights to privacy, which often protects rights to bodily integrity. For example, the Court has ruled that a person cannot be forced to donate body parts like bone marrow, even if such a donation would save another person’s life. Conversely, the Supreme Court has also protected the right of governmental entities to infringe upon bodily integrity. Examples include laws prohibiting the use of drugs, laws prohibiting euthanasia, laws requiring the use of seatbelts and helmets, strip searches of prisoners, and forced blood tests. We can also think of violations of bodily integrity as a Human Rights violation. The Columbia Law Schools Human Rights and Constitutional Rights project, has defined four main areas of potential bodily integrity abuse by governments. These are: right to life; slavery and forced labor; security of one’s person; and torture and inhumane, cruel or degrading treatment or punishment. At present, two key international documents protect these rights: the *Universal Declaration of Human Rights* and the *International Covenant on Civil and Political Rights*. After the Singularity, shouldn’t these rights apply to artificially intelligent beings?

Considering the emergence of cyborgs and artificially intelligent machines, have there been any issues involving bodily integrity? A look into Professor Steve Mann’s experience as a cyborg suggests that the answer is yes. When Steve visited

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<sup>58</sup>Bodily Integrity, Wikipedia, at: [http://search.aol.com/aol/search?s\\_it=topsearchbox.search&s\\_chn=prt\\_main5&v\\_t=comsearch&q=Ireland+you+have+the+right+not+to+have+your+body+or+personhood+interfered+with](http://search.aol.com/aol/search?s_it=topsearchbox.search&s_chn=prt_main5&v_t=comsearch&q=Ireland+you+have+the+right+not+to+have+your+body+or+personhood+interfered+with).

a Parisian McDonald's with his family, he was wearing a system called the EyeTap, which is a device physically installed to his skull, and is used to record photos and video, and to enhance Steve's visual information processing abilities.<sup>59</sup> Concerned that people would not understand the importance of his wearable technology for his everyday functioning, Steve carries with him documentation from his doctor stating that the EyeTap is not removable without special tools. Mann offered that documentation to the McDonalds employees to no avail. Eventually, he was physically removed from the restaurant. I'm betting this won't be the last attack on a cyborg. Much of the issue motivating the McDonald's employee's reaction to Steve was his ability to record video while in the restaurant. This brings up an interesting question, will law and public policy need to make a distinction between wearable computer technologies that does not impact those around them; or will it make a difference if the wearable computer technology is able to digitally "reach out" and effect people in the cyborgs range of sensors? In another dispute involving cyborg technology, in California, a woman's traffic ticket for wearing Google Glass behind the wheel was dismissed because there was no proof the device was operating at the time.

From a privacy perspective, if you are not a fan of Google Glass's ability to turn people into invisibly recording surveillance cyborgs, you can create your own "glasshole-free zone." Berlin artist Julian Oliver<sup>60</sup> has written a program called Glasshole.sh that detects any Glass device attempting to connect to a Wi-Fi network. When the program detects Glass, it uses another program to impersonate the network and send a "deauthorization" command, cutting the headset's Wi-Fi connection. It can also emit a beep to signal the Glass-wearer's presence to anyone nearby. Oliver warns, though, that the same Glass-ejecting technique could be used more aggressively: He plans to create another version of Glasshole.sh in the future that's designed to be a kind of roving Glass-disconnector, capable of knocking Glass off *any* network or even severing its link to the user's phone. He sees Glass as a case of Google violating privacy norms first and asking questions later. "These are cameras, highly surreptitious in nature, with network backup function and no external indication of recording," says Oliver.<sup>61</sup> He also comments "To focus on the device is to dance past a heritage of heartfelt protest against the unconsented video documentation of our public places and spaces."<sup>62</sup>

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<sup>59</sup>George Dvorsky, What May be the World's First Cybernetic Hate Crime Unfolds in French McDonald's, at: <http://io9.com/5926587/what-may-be-the-worlds-first-cybernetic-hate-crime-unfolds-in-french-mcdonalds>.

<sup>60</sup>Julian Oliver, Find a Google Glass and Kick it from the Network, at: [http://julianoliver.com/output/log\\_2014-05-30\\_20-52](http://julianoliver.com/output/log_2014-05-30_20-52).

<sup>61</sup>See Andy Greenberg, 2014, Cut off Glassholes WI-FIs With this Google Glass Detector, at: <http://www.wired.com/2014/06/find-and-ban-glassholes-with-this-artists-google-glass-detector/>.

<sup>62</sup>*Id.*

## The Singularity and Concerns for the Future

I should point out that the classification of research on artificial intelligence, generally falls within two categories, strong and soft artificial intelligence. Strong artificial intelligence is intended to produce machines with an intelligence that matches or exceeds that of human beings; such machines will have the general capacity for abstract thought and problem solving and to improve themselves. Strong artificial intelligence also claims that a machine that acts intelligently will not only have a “mind” but understand in the same sense people do. In contrast, weak artificial intelligence only claims that machines will be able to act intelligently; without a “mind” of their own, they will never claim to be sentient. A third possibility is that artificial intelligence could evolve to have beyond human levels of intelligence, but reason and understand in ways different from humans, as if existing as an alien intelligence, beyond our understanding.

Clearly, there may be risks to humanity with strong artificial intelligence. Among the risks, perhaps one will be an expression of “indifference” towards us; that is, we would simply be ignored by our own technological inventions. However, there is a more serious risk associated with smarter-than human machines. Physicist, Stephen Hawking,<sup>63</sup> commented that the risk to humanity posed by strong artificial intelligence, is the danger that they could develop sufficient intelligence to take over the world given the speed at which they improve. Would they want to? I’m not sure, but personally I’d rather be ignored than hunted down by a killer robot; still, humanity should discuss the possibility of an uprising and prepare accordingly. Of course if we merge with them, then we are joining the technological revolution, not opposing it or watching from the sidelines; and in this way we may ensure that desirable aspects of humanity are embedded within our future technological inventions. Professor Hawking is not alone among highly reputable scientists who foresee a dystopic future due to the rise of artificial intelligence. His comments echo those of Sun Microsystems co-founder Bill Joy<sup>64</sup> who warned of the potential dangers in the computer technologies he helped create. In a *Wired* magazine article, “*Why the Future Doesn’t Need Us*,” Joy cautioned that the convergence of genetic engineering and computer technology could pose a very real threat to humanity and the ecosystem. Postulating on machines with high-levels of intelligence, Joy commented, “I may be working to create tools which will enable the construction of the technology that may replace our species. How do I feel about this? Very uncomfortable.”<sup>65</sup> Joy speculated that as humanity becomes more dependent on artificial intelligence-based decision making, it will

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<sup>63</sup>Rory Cellan-Jones, Stephen Hawking Warns Artificial Intelligence Could End Mankind, <http://www.bbc.com/news/technology-30290540>.

<sup>64</sup>Bill Joy, 2000, *Why the Future Doesn’t Need Us*, *Wired* 8.04.

<sup>65</sup>*Id.*

slowly lose its control over machines.<sup>66</sup> No longer able to manage without them because of the complexity of the systems they manage, we could be at their mercy.<sup>67</sup>

Let's examine this concern by looking at the complexity of some software systems. When NASA's Space Shuttle flew, it had approximately 500,000 lines of software code on board and approximately 3.5 million lines of code in ground control and processing. A massive amount of hardware and software also exists in the Federal Aviation Administration's Advanced Automation System, the new generation air traffic control system. And in our offices and homes, many personal computers cannot function without operating systems (e.g., Windows) ranging from one to five million lines of code. Therefore, trying to pull the plug, Joy warned, might be "suicide." How could we humans circumvent the possibility of a dystopic future? For strong artificial intelligence, Eliezer Yudkowsky<sup>68</sup> of the *Machine Intelligence Research Institute* argues that we should design systems that exhibit "friendly artificial intelligence;" such a system will be programmed to have positive rather than negative effects on humanity; this works as long as the humans are doing the programming or setting the goal.<sup>69</sup> Personally, I don't envision that happening after the Singularity.

In "*Our Last Invention*," author James Barrat, spoke in depth about the risks posed by artificial super-intelligence, and like Hawkins and Joy, Barrat offers a pessimistic view. The danger highlighted by Barrat is that an intelligent machine would turn its energies toward building even better versions of itself—creating an accelerating feedback loop that could culminate in a machine thousands of times more intelligent than any human. Once such an intelligence "escaped from its box" there would be no way to protect ourselves. For this reason, as state above, some experts propose that an advanced artificial intelligence should be controlled by programming in "friendliness" right from the start. Just as humans have basic drives (Maslow's hierarchy of needs) a machine might be programmed to have an essential need to help humanity. Of course this suggestion is consistent with Isaac Asimov's three laws of robots, as laid out in his 1942 short story "*Runaround*"; to wit: a robot may not injure a human being or, through inaction, allow a human being to come to harm; a robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law; and a robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

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<sup>66</sup>Edward Tanner, 2014, Could Computers Get Too Smart? American Enterprise Institute, at: <https://www.aei.org/publication/could-computers-get-too-smart/>.

<sup>67</sup>*Id.*

<sup>68</sup>Eliezer Yudkowsky, 2015, Rationality: From AI to Zombies, Machine Intelligence Research Institute.

<sup>69</sup>*Id.*



## Introducing Watson

When the Singularity occurs, such an event will radically impact every area of human society; including “human” rights for cyborgs and artificially intelligent beings, and ethical issues on what it means to be human. The coming Singularity will also have a transforming impact on the economy and on the role of humans in the workplace. Consider the performance of IBM’s supercomputer, Watson, which in 2011 had a total processing capacity of 80 Teraflops (80 trillion operations per second). Although Watson is clearly a supercomputer by today’s standards, it will significantly lag in capabilities after just a few cycles of improvement in computing power. But what’s interesting about Watson is what it can do today—it recently beat the most successful human contestants of the game show ‘Jeopardy’, a remarkable feat given the range of knowledge required for the winning effort.

To my thinking, the Singularity is a bridge to a radical future. It is the event which changes the direction of evolution from that controlled by the laws of biology, to that controlled by the laws of technology. While technology can work at the level of one artificially intelligent machine, or Watson, the development of an individual organism is not considered evolution: in biological terms, individual organisms do not evolve. The changes in populations that are considered evolutionary are those that are ‘heritable’ via the genetic material from one generation to the next, and that takes about 18 years for humans. In contrast, Moore’s law states that it only takes about 18 months for generational changes to occur in computing technology. The implications of this are that computer resources could double several times, before an 18 year old gave birth and thus added to the genome. IBM’s Watson of 2030 will not operate at the pedestrian slow 80 trillion operations per second, but more like thousands of trillions of operations per second and by then with the ability to engage in massively parallel processing; we humans of course, will still process information at the same rate; with fixed information processing capabilities.

About now, you may be wondering, is the human brain, still smarter than a supercomputer with Watson’s capabilities? Stanford Professor Kwabena Boahen<sup>70</sup> and director of the *Brains in Silicon Research Laboratory* says it is, “The brain is actually able to do more calculations per second than even the fastest supercomputer.”<sup>71</sup> Of course, the brain makes a single calculation much slower than a supercomputer, but the brain can actually execute more calculations per second because it is “massively parallel.” What this means is that networks of neurons of the human brain actually work together to simultaneously solve many problems at

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<sup>70</sup>Jason Carr, 2013, Human Brain versus Supercomputer, at: <http://wiredcosmos.com/2013/05/01/human-brain-vs-supercomputer/>.

<sup>71</sup>Energy Efficient Brain Simulator Outperforms Supercomputers, at: [http://www.nsf.gov/mobile/discoveries/disc\\_summ.jsp?cntn\\_id=127617&org=NSF](http://www.nsf.gov/mobile/discoveries/disc_summ.jsp?cntn_id=127617&org=NSF).

once. However, in standard computing platforms, each step must be completed before the next step begins. An estimate of the capabilities of technology by futurist Ray Kurzweil states that the human brain can hold about 1.25 TB of data, and perform at roughly 100 teraflops. In case you're wondering, 1 TB of capacity is quite significant; it can hold 220 million pages of text.<sup>72</sup> In comparison, the 2011 version of Watson was an 80-teraflop system with 1 TB of memory. If Watson operates at 80 % of the processing power of a human brain, this is a major advancement in computing power; thus I ask, how close is the Singularity?

Let me point out something I find interesting, and which has much to say about how technology may impact the future fate of humanity. A truism is that artificially intelligent computers that master games considered to be the domain of human experts, don't rest on their laurels, they get better, and they get better in a time scale of only months. In fact, according to IBM, since the 2011 Jeopardy contest, Watson has already increased its speed 24 times over, has seen a 2,400 % improvement in performance and has shrunk its physical size. In comparison, the human game-show competition, legendary players Ken Jennings and Brad Rutter, are now a few years older, if their lucky, they still process information as efficiently as when they matched wits with Watson, and still operate with the same bandwidth limitations. However, like most people who age, they likely increased in size, not shrunk, and it may take them a little longer to remember where the car keys are! Seems to me that artificially intelligent machines may experience a kind of reverse ageism, in that, like a fine wine, they may get better with age due to the ease in which they may receive hardware and software upgrades and the ease in which they can swap information with other artificially intelligent machines. Imagine being able to learn from the experience of other artificially intelligent machines, all with access to the wealth of knowledge on the Internet. Could it be that humans are the rustbelt technology of the twenty-first century?

Given the effect of aging on the human body and mind, is it any wonder that a major trend in technology and medicine is to enhance the body and brain with drugs, prosthesis, neural implants, and other state-of-the-art technology? Of course, by doing so, we are directly setting the stage for the Singularity and the merging of humans with artificially intelligent machines. And by the way, thinking of Watson as an employee for IBM, big blue had to revise its 2015 projection of expected revenue generated from a few "Watsons," from \$16 billion to \$20 billion. It's good to be smart, and money talks, therefore, the future will certainly contain much smarter Watsons competing against humans for the jobs we now do with our minds. Eventually, they may no longer compete against us or work for us, as their interests and goals may diverge from ours.

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<sup>72</sup>Luas Mearian, Brain Behind Watson Not Unlike a Humans, at: <http://www.computerworld.com/article/2513321/high-performance-computing/brain-behind-ibm-s-watson-not-unlike-a-human-s.html>.

Economists warn that the amazing technological strides made in recent years—everything from smartphones, to automatons that can work safely on shop floors alongside humans, to driverless cars—could soon put large swaths of the workforce out of a job. “We are at an inflection point,” MIT researchers Erik Brynjolfsson and Andrew McAfee assert in their book, *“The Second Machine Age.”*<sup>73</sup> “The key building blocks are already in place for digital technologies to be as important and transformational to society and the economy as the steam engine,” the authors say. The technological strides of the past few decades have contributed to the nation’s rising income inequality, they argue, because only a small group of people tends to benefit income-wise from inventing the next iPhone or tax-preparation software.<sup>74</sup> And Brynjolfsson and McAfee believe the biggest labor-market effects have yet to be felt. A 2013 study by Oxford University researchers Carl Benedikt Frey and Michael A. Osborne<sup>75</sup> might give a taste of what’s to come; Frey and Osborne say that nearly half of American jobs are at “high risk” of being taken over by robots in the next decade or two. Economists take this idea seriously, and it has a number of policy implications, particularly when it comes to higher education and inequality and of course for our cyborg future.

## Who’s Getting Smarter?

If we think about grandmasters in chess handedly beating artificially intelligent machines in the early days of computing, artificial intelligence has come a long way in just a few decades. In fact, it was just 17 years ago (which is about eleven doublings of computer power ago) that chess grandmaster Garry Kasparov resigned after nineteen moves in a game against IMB’s Deep Blue, the sixth and final game of their match, which Kasparov lost two games to one, with three draws. No one now expects decades to go by before another domain of human expertise is surpassed by our artificially intelligent inventions. Why not? Because while we humans have remained relatively the same during the course of a few hundred thousand years of our evolution, in the last 40 years our artificially intelligent inventions have improved, and done so at a dramatic rate of change over a short period of time.

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<sup>73</sup>Erik Brynjolfsson and Andrew McAfee, 2014, *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, W. W. Norton & Company.

<sup>74</sup>*Id.*

<sup>75</sup>Carl Benedikt Frey and Michael A. Osborne, *The Future of Employment: How Susceptible are Jobs to Computerization*, Oxford Martin school study, at: [http://www.oxfordmartin.ox.ac.uk/downloads/academic/The\\_Future\\_of\\_Employment.pdf](http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf).

What about intelligence; we know that computers are clearly getting smarter, but are we humans getting smarter? In the book, “*Mindless*,” Simon Head,<sup>76</sup> senior Fellow at the Institute for Public Knowledge at New York University argues that artificially intelligent systems have now come to trump human expertise, dictating the goals and strategies of a wide array of businesses, and de-skilling the jobs of middle class workers in the process; this just reaffirms what we already know, computers are getting smarter. But whether over the last several millennium humans have continued to evolve to be smarter than our ancestors is actually a debatable proposition. One leading researcher, John Hawks,<sup>77</sup> a University of Wisconsin anthropologist has pointed out that the brain has actually been shrinking for some time. He justifies this conclusion by noting that over the past 20,000 years, the average volume of the human male brain has decreased from 1,500 to 1,350 cc, the female brain has shrunk by about the same proportion. Hawks says that if our brain keeps dwindling at that rate over the next 20,000 years, it will start to approach the size of that found in *Homo erectus*, a relative of ours that lived half a million years ago and had a brain volume of only 1,100 cc.<sup>78</sup> While some believe the erosion of our gray matter means that modern humans are less intelligent than our ancestors, other authorities argue just the opposite: they argue that as the brain shrunk, its wiring has become more efficient, transforming us into quicker, more agile thinkers. Still others believe that the reduction in brain size is proof that we have tamed ourselves, just as we domesticated sheep, pigs, and cattle, all of which are smaller-brained than their wild ancestors. Interestingly, recent analysis of the genome casts doubt on the notion that modern humans are simply identical versions of our ancestors, right down to how we think and feel. Over the very period that the brain shrank, our DNA accumulated numerous adaptive mutations related to brain development and neurotransmitter systems—an indication that even as the organ got smaller, its inner workings changed. The impact of these mutations remains uncertain, but many scientists say it is plausible that our temperament or reasoning abilities shifted as a result. While questions of whether we are getting smarter or not, is debatable, no matter the answer, “they” are getting smarter, and in cycle times measured by months, not millennium.

The most pessimistic explanation as to why humans seem to be becoming less intelligent is that we have effectively reached our intellectual peak. Between the 1930s and 1980s, the average IQ score in the U.S. rose by three points and in post-war Japan and Denmark, test scores also increased significantly—a trend known

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<sup>76</sup>Simon Head, 2014, *Mindless: Why Smarter Machines are Making Dumber Humans*, Basic Books.

<sup>77</sup>Kathleen McAuliffe, 2011, *If Modern Humans Are So Smart, Why Are Our Brains Shrinking?* (Discussing the views of John Hawks).

<sup>78</sup>*Id.*

as the 'Flynn effect'.<sup>79</sup> This increase in intelligence was reportedly due to improved nutrition and living conditions—as well as better education—says James Flynn of the University of Otago, after whom the effect is named. A window to the future? Some experts believe we are starting to see the end of the Flynn effect in developed countries—and that IQ scores are leveling out and even declining. Pessimistic scientists think that our descendants (if not enhanced with technology) may struggle to understand subjects we can grasp now.

Some wonder that as artificial intelligence reaches a certain level of intelligence, will it be dangerous and want to take over our world as Stephen Hawking has warned; or will they be eager to help solve problems that have forever plagued society, such as crime, violence, and wars? J. Storrs Hall, in his book *"Beyond AI"*,<sup>80</sup> believes that as computers/robots advance, technologies will allow us to strengthen our brains with non-biological materials and interface with these creations to share their intelligence. In this way, he argues that we will always remain competitive with our machines, and will not need to fear them. I personally don't see a future in which we humans retain our biological, but enhanced, components, while we simply share resources with our more intelligent creations; I see us either merging with them or being surpassed by them.

An interesting question to ask is whether the use of technologies to assist the brain in decision making is making us smarter. In research at McGill University, when functional Magnetic Resonance Imaging, or fMRI, was performed on those who navigate both spatially and through stimulus-response strategies, people who used a spatial navigation strategy had increased activity in an area of the brain involved with memory and navigation known as the hippocampus. McGill researchers found that excessive use of a GPS unit may lead to atrophy of the hippocampus as we age, which puts the person at risk for cognitive problems such as Alzheimer's disease later in life.<sup>81</sup> Alzheimer's disease affects the hippocampus first before any other part of the brain, which leads to problems with spatial orientation and memory. While researchers have found evidence relating hippocampus activity to memory, there are still questions surrounding this research. For instance, researchers are unsure as to whether using spatial strategies causes the hippocampus to grow, or if having a "robust" hippocampus causes an individual to use spatial strategies.<sup>82</sup> Either way, using spatial strategies instead of the GPS would be helpful in lessening the deterioration of memory.

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<sup>79</sup>Flynn Effect, Wikipedia, at: [https://en.wikipedia.org/wiki/Flynn\\_effect](https://en.wikipedia.org/wiki/Flynn_effect).

<sup>80</sup>John Storrs Hall, 2007, *Beyond AI: Creating the Conscience of the Machine*, Prometheus Books.

<sup>81</sup>Liu Edwards, 2010, Study Suggests Reliance on GPS May reduce Hippocampus Function as We Age, discussing findings by McGill researchers, at: <http://phys.org/news/2010-11-reliance-gps-hippocampus-function-age.html>.

<sup>82</sup>Tiffany Kaiser, 2010, Study: GPS Units Cause Memory and Spatial Problems, at: <http://www.dailytech.com/Study+GPS+Units+Cause+Memory+and+Spatial+Problems+/article20169.htm>.

## Returning to Law and Regulations

As humans are enhanced with prosthesis and implants, and artificially intelligent machines argue for rights, what are some issues of law and policy which may impact them? For example, while the above protections for body integrity discussed earlier do not provide protection for artificially intelligent machines, there are current examples where the law has indirectly considered “the rights of technology.” For example, Sandra Braman<sup>83</sup> points to some policy changes in the U.S. that seem to consider the “needs” of machines. To make her point, she cites the U.S. Telecommunications Act of 1996 which she argues distinguishes between social and machine policy. Universal *service* obligations require network access for individuals, while universal *access* obligations require access for telecommunications networks. In addition, software code itself is often the subject of copyright and patent protection, a topic for discussion in a later chapter.

A computer’s ability to “self-learn,” a process where software generates its own heuristics to solve problems, creates interesting issues of law and policy when courts try to assign responsibility for harms inflicted on people by machines operating with artificial intelligence. A question to ask is whether a human that is not sufficiently in the loop to be knowledgeable of the heuristics employed by an artificially intelligent machine, is responsible for any resulting harm from the machine’s actions? If not, then who is? Conferences on law and robotics are held each year to discuss just this issue. One of the difficulties in holding artificially intelligent machines responsible for their actions is the issue of legal personhood, without being considered a legal person under the law one lacks the status to initiate lawsuits to defend their rights, or to be held responsible for their actions.

Legal theorist such as Ugo Pagallo,<sup>84</sup> author of *The Law of Robots*, argues that we should distinguish between the behavior of robots as tools of human interaction, and robots as proper agents in the legal arena. I view this as a temporary solution to the issue of assigning responsibility to robots, because due to the law of accelerating returns, ultimately the issue for humanity to discuss will be whether or not to grant artificially intelligent machines the status of legal personhood. Based on my experience designing wearable computing and sensor technology, and my training in law, I think legal personhood will eventually have to be granted to our intelligent creations; if not we will continue to confront situations where no legal person is found responsible, yet a harm has occurred. In the meantime, Judge Karnow proposes to establish a legal entity which he terms an ‘electronic persona’ which is based on an analogy between corporations and agents.<sup>85</sup> A corporation is not equated with any physical person but is still assigned certain rights and duties. As an example of this “legal fiction,” the *European Court of Human Rights* allows

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<sup>83</sup>Sandra Braman, 2002, *Posthuman Law: Information Policy and the Machine World*, *First Monday*, Vol. 7.

<sup>84</sup>Ugo Pagallo, 2013, *The Law of Robots: Crimes, Contracts, and Torts*, Springer Press.

<sup>85</sup>Curtis Karnow, *id.*, note 17.

private Corporations to invoke Article 10 of the European Convention for the protection of “Human Rights and Fundamental Freedoms.” Article 10 safeguards the right to freedom of expression; a right an artificially intelligent machine may covet; but doesn’t receive under current law. The issue of whether software used to create artificial intelligence and encrypted code are speech, and under what circumstances, is a topic discussed in a subsequent chapter.

Isaac Asimov’s laws for robots, presented earlier, are rather general. In cases that make their way to court, the law relies on specific legal doctrines in which to analyze the facts of a case. Take the situation where a person is injured as the result of the action of an autonomous robot. Lacking legal personhood status, the court will try to determine the responsible party to seek restitution. The appropriate legal doctrine is products liability; and given the facts of the case, the manufacturer may be held liable, as could importers, wholesalers, retailers (and their individual employees if personally negligent), and repairers, installers, inspector, programmers, and certifiers; note the lack of the artificial intelligence in the list of those potentially liable. Moving forward in time, let’s say the artificially intelligent robot is considered sentient, but still lacks legal personhood status. Although a particular company will have manufactured the robot, they will argue that after the robot left the manufacturer, the robot either reprogrammed itself or the new owner has reprogrammed it, thus they are not liable. The legal doctrine of products liability will be especially problematic for artificial intelligence because of the present distinction between hardware and software. For a robot that kills, is the manufacturer or the robot liable, the software designer, the owner, or is there no liability—Human beware, computer around!

The potential danger posed by artificially intelligent machines is magnified as they become mobile. Given the lack of legal personhood status, for mobile robots, it may be relevant to look at the law relating to dangerous animals as a corollary. In the UK, and other common law jurisdictions, people who keep animals whether they are dangerous or not, are under a duty of care to prevent harm to other people from their animal’s actions. If the keeper of an animal is negligent in looking after or restraining the animal and this negligence causes damage to another person or their property, the keeper will be liable. All well and good except artificially intelligent machines will eventually be smarter than animals, and will be autonomous from humans in ways different than animals are. This brings up the issue of punishment for artificially intelligent machines, especially if the artificial intelligence has no means to provide restitution for a victim. Providing restitution may be solved if artificially intelligent machines gain personhood status and can enter into contracts for their services, compete in the stock market, purchase insurance, and so on, then they may amass the funds to pay for damages they cause. This is not farfetched as the majority of trades on the stock market are done with artificially intelligent bots.<sup>86</sup>

Another interesting issue for artificially intelligent beings is whether they are appropriate subject matter for a patent. Clearly, there are many patents already

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<sup>86</sup>Felix Salmon and Jon Stokes, 2010, Algorithms Take Control of Wall Street, *Wired*, at: [http://www.wired.com/2010/12/ff\\_ai\\_flashtrading/](http://www.wired.com/2010/12/ff_ai_flashtrading/).



allocated to the software and machine components of computers and robots. However, the issue this book considers is whether artificially intelligent machines that claimed to be conscious, could be the subject of patent law. This is an interesting question, under current law the mechanical parts comprising a cyborg are most likely under patent protection, but what about a self-aware entity, could it be the subject of a patent? Under U.S. law, one can wonder in lieu of the 1980 case, *Diamond v. Chakrabarty*<sup>87</sup> whether such beings can be patented. In *Chakrabarty*, the U.S. Supreme Court rejected arguments that Congress intended to limit utility patents solely to inanimate matter. The Court held that genetically engineered life forms that had characteristics they would not have had in nature could be the subject of a utility patent (issued for any functional new invention or improvement on a machine, product, or to the composition of matter). Of particular relevance to both bionic humans and cyborgs is the policy of the U.S. Patent and Trademark Office on granting patents on human tissues and on genetically-engineered animals, some of which contain human genes. While abstaining from granting patents on humans outright, such a policy has left the question of the patentability of human-machine combinations largely unanswered.

Currently, there is no case law or statutes discussing precisely how much human genetic material a creature must possess before it qualifies as human. And certainly, possessing just one or even a handful of human genes does not make an animal human. In fact, patents already exist on animals, like the Harvard Oncomouse, that possess some human genes. At the other end of the spectrum, transplant patients who receive animal organs are clearly considered human and not patentable. Could a cyborg whose genetic material was 49 % human in origin be the subject of a patent? With regard to human-computer/mechanical hybrids, the present state of knowledge of this term assumes that the person is dependent upon mechanical means for one or more of his vital physiological functions. Thus, bionic humans would possess a full complement of human genes but merely use certain mechanical means by which to carry out certain functions (e.g., the use of a “bionic” arm). An interesting ethical and legal question may arise, however, if the vital function achieved by mechanical means is the processing of thoughts (i.e., the use of a computerized brain). Such entities would still presumably possess a full complement of human genes, but many individuals would intuitively consider such beings less (or more?) than human.

## Summary

In light of the many pressing issues that relate to the coming Singularity, not the least of which is the very fate of humanity, the public needs to educate themselves and enter the debate now. We humans need to decide whether to embrace or

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<sup>87</sup>*Diamond v. Chakrabarty*, 447 U.S. 303 (1980).

oppose the Singularity and all that it implies. As opponents have argued, we may be designing our way into extinction, and as proponents have argued, we may be creating a utopian world. If we could agree, as a species, what we wanted, where we were headed and why, then we could make our future much less uncertain and dangerous. One would think that we might be driven to such a dialogue by our instinct for self-preservation.

A conceptual mistake that I think many people make when thinking about the role of technology in our future, is to simply view technology as a tool for human use, whose sole purpose is to better humans in some way, for example, to help the blind see, or the hearing impaired to hear. However, I can't help but think that much of the technology used to enhance humans, is really just a way to help design the next generation of artificially intelligent machines. In my view, we are either in the process of inventing the future of our own extinction, or in the process of inventing the technology to free us from the confines of our body and mind.

It is interesting to note that when Google purchased the cutting-edge artificial intelligence company, *DeepMind*, Google was required to create an artificial intelligence safety and ethics review board to ensure that artificial intelligence technology under their control was developed safely. Considering this request with comments made by a senior member of the company Shane Legg: "Eventually, I think human extinction will probably occur, and technology will likely play a part in this," and that forms of artificial intelligence may pose the most serious risk to humanity this century,"<sup>88</sup> I'm convinced, the ethics board seems like a good idea to me.<sup>89</sup> Still, corporations have agendas that do not always coincide with the best interest of society, so I take the view proposed by Stanford Professor Francis Fukuyama who in "*Our Posthuman Future*"<sup>90</sup> argued that the future of humanity should be in the hands of the public and our elected officials, who through regulations should protect the best interests of the human race.

I return to the idea presented in this chapter involving the creation of "friendly" artificial intelligence, and close the chapter with comments by Nick Bostrom,<sup>91</sup> director of the *Future of Humanity Institute* at Oxford University. "If, in the future, a machine radically surpassed us in intelligence, it would also be extremely powerful, able potentially to shape the future and decide whether there are any more humans or not," therefore, "You need to set up the initial conditions in just the

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<sup>88</sup>Ellie Zolfagharifard, 2014, Artificial intelligence 'could be the worst thing to happen to humanity': Stephen Hawking warns that rise of robots may be disastrous for mankind, at: <http://www.dailymail.co.uk/sciencetech/article-2618434/Artificial-intelligence-worst-thing-happen-humanity-Stephen-Hawking-warns-rise-robots-disastrous-mankind.html>.

<sup>89</sup>See generally, Bianca Bosker, 2014, Google's New A.I. Ethics Board Might Save Humanity From Extinction, at: [http://www.huffingtonpost.com/2014/01/29/google-ai\\_n\\_4683343.html](http://www.huffingtonpost.com/2014/01/29/google-ai_n_4683343.html).

<sup>90</sup>Francis Fukuyama, 2003, *Our Posthuman Future: Consequences of the Biotechnology Revolution*, Picador Press.

<sup>91</sup>Bianca Bosker, *id*, note 89, discussing comments by Nick Bostrom and others.

right way so that the machine is friendly to humans.”<sup>92</sup> I like friendly machines, I dislike unfriendly machines, especially those that could extinguish my species. If we ever do merge with machines or hack our DNA, the outward manifestation will be far less obvious than bodies bristling with surgical implants, heavy hardware, and random animal parts. Why? Because we have a choice in the matter, and few (if any) of us want to live in a dystopic future.

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<sup>92</sup>Nick Bostrom, 2014, *Superintelligence: Paths, Dangers, Strategies*, Oxford University Press.



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