

Art by Dave Plunkert ©Images.com/Corbis

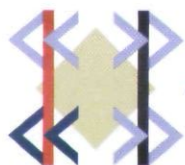


THE NEXT FRONTIER

Fasten your seatbelts, says one of the world's leading futurists. We are headed toward a transformation unlike anything we have ever experienced—and are only beginning to understand the implications.

BY RAY KURZWEIL

From The Singularity Is Near by Ray Kurzweil
Copyright © 2005 by Ray Kurzweil. Printed by arrangement with Viking Penguin, a member of Penguin Group (USA) Inc.



I AM NOT SURE when I first became aware of the Singularity. I'd have to say it was a progressive awakening. In the almost half-century that I've immersed myself in computer and related technologies, I've sought to understand the meaning and purpose of the continual upheaval that I have witnessed at many levels. Gradually, I've become aware of a transforming event looming in the first half of the twenty-first century. Just as a black hole in space dramatically alters the patterns of matter and energy accelerating toward its event horizon, this impending Singularity in our future is increasingly transforming every institution and aspect of human life, from sexuality to spirituality.

What, then, is the Singularity? It's a future period during which the pace of technological change will be so rapid, its impact so deep, that human life will be irreversibly transformed. Although neither utopian nor dystopian, this epoch will transform the concepts that we rely on to give meaning to our lives, from our business models to the cycle of human life, including death itself. Understanding the Singularity will alter our perspective on the significance of our past and the ramifications for our future. To truly understand it inherently changes one's view of life in general and one's own particular life.

I can understand why many observers do not readily embrace the obvious implications of what I have called the law of accelerating returns (the inherent acceleration of the rate of evolution, with technological evolution as a continuation of biological evolution). After all, it took me forty years to be able to see what was right in front of me, and I still cannot say that I am entirely comfortable with all of its consequences.

The key idea underlying the impending Singularity is that the pace of change of our human-created technology is accelerating and its powers are expanding at an exponential pace. Exponential growth is deceptive. It starts out almost imperceptibly and then explodes with unexpected fury—unexpected, that is, if one does not take care to follow its trajectory.

Consider Garry Kasparov, who scorned the pathetic state of computer chess in 1992. Yet the relentless doubling of computer power every year enabled a computer to defeat him only five years later. The list of ways computers can now exceed human capabilities is rapidly growing. Moreover, the once narrow applications of computer intelligence are gradually broadening in one type of activity after another. For example, computers are diagnosing electrocardiograms and medical images, flying and landing airplanes, controlling the tactical decisions of automated weapons, making credit and financial decisions, and

being given responsibility for many other tasks that used to require human intelligence. The performance of these systems is increasingly based on integrating multiple types of artificial intelligence (AI). But as long as there is an AI shortcoming in any such area of endeavor, skeptics will point to that area as an inherent bastion of permanent human superiority over the capabilities of our own creations.

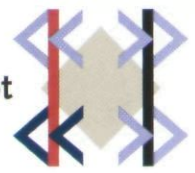
Within several decades, information-based technologies will encompass all human knowledge and proficiency, ultimately including the pattern-recognition powers, problem-solving skills, and emotional and moral intelligence of the human brain itself.

Although impressive in many respects, the brain suffers from severe limitations. We use its massive parallelism (100 trillion interneuronal connections operating simultaneously) to quickly recognize subtle patterns. But our thinking is extremely slow; the basic neural transactions are several million times slower than contemporary electronic circuits. That makes our physiological bandwidth for processing new information extremely limited compared to the exponential growth of the overall human knowledge base. Our version 1.0 biological bodies are likewise frail and subject to a myriad of failure modes, not to mention the cumbersome maintenance rituals they require.

The Singularity will allow us to transcend these limitations of our biological bodies and brains. We will gain power over our fates. Our mortality will be in our own hands. We will be able to live as long as we want (a subtly different statement from saying we will live forever). We will fully understand human thinking and will vastly extend and expand its reach. By the end of this century, the nonbiological portion of our intelligence will be trillions of trillions of times more powerful than unaided human intelligence.

We are now in the early stages of this transition. The acceleration of paradigm shift (the rate at which we change fundamental technical approaches), as well as the exponential growth of the capacity of information technology, are both beginning to reach the "knee of the curve," which is the stage at which an exponential trend becomes noticeable. Shortly after this stage, the trend quickly becomes explosive. Before the middle of this century, the growth rates of our technology—which will be indistinguishable from our selves—will be so steep as to appear essentially vertical. From a strictly mathematical perspective, the growth rates will still be finite but so extreme that the changes they bring about will appear to rupture the fabric of human history. That, at least, will be the perspective of unenhanced biological humanity.

By the end of
this century, the
nonbiological portion
of our intelligence
will be trillions of
trillions of times
more powerful than
unaided human
intelligence.



The Singularity will represent the culmination of the merger of our biological thinking and existence with our technology, resulting in a world that is still human but that transcends our biological roots. There will be no distinction, post-Singularity, between human and machine or between physical and virtual reality. If you wonder what will remain unequivocally human in such a world, it's simply this quality: Ours is the species that inherently seeks to extend its physical and mental reach beyond current limitations.

Many commentators on these changes focus on what they perceive as a loss of some vital aspect of our humanity that will result from this transition. This perspective stems, however, from a misunderstanding of what our technology will become. All the machines we have met to date lack the essential subtlety of human biological qualities. Although the Singularity has many faces, its most important implication is this: Our technology will match and then vastly exceed the refinement and suppleness of what we regard as the best of human traits.

The 2010 Scenario

Computers arriving at the beginning of the next decade will become essentially invisible: woven into our clothing, embedded in our furniture and environment. They will tap into the worldwide mesh (what the World Wide Web will become once all of its linked devices become communicating Web servers, thereby forming vast supercomputers and memory banks) of high-speed communications and computational resources. We'll have very high-bandwidth, wireless communication to the Internet at all times. Displays will be built into our eyeglasses and contact lenses and images projected directly onto our retinas. The Department of Defense is already using technology along these lines to create virtual-reality environments in which to train soldiers.

An impressive, immersive virtual-reality system already demonstrated by the Army's Institute for Creative Technologies includes virtual humans that respond appropriately to the user's actions. Similar tiny devices will project auditory environments. Cell phones are already being introduced in clothing that projects sound to the ears. And there's an MP3 player that vibrates your skull to play music that only you can hear. The Army has also pioneered transmitting sound through the skull from a soldier's helmet.

There are also systems that can project sound from a distance that only a specific person can hear, a technology that was dramatized by the personalized talking street ads in the movie *Minority Report*. These resources will provide high-resolution,

full-immersion, visual-auditory virtual reality at any time. We will also have augmented reality with displays overlaying the real world to provide real-time guidance and explanations. For example, your retinal display might remind us, "That's Dr. John Smith, director of the ABC Institute—you last saw him six months ago at the XYZ conference" or, "That's the Time-Life Building—your meeting is on the tenth floor."

We'll have real-time translation of foreign languages, essentially subtitles on the world, and access to many forms of online information integrated into our daily activities. Virtual personalities that overlay the real world will help us with information retrieval and our chores and transactions. These virtual

assistants won't always wait for questions and directives, but will step forward if they see us struggling to find a piece of information (as we wonder about "that actress ... who played the princess, or was it the queen ... in that movie with the robot," our virtual assistant may whisper in our ear or display in our visual field of view: "Natalie Portman as Queen Amidala in *Star Wars*").

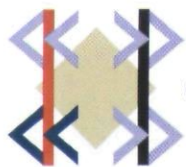
The 2030 Scenario

Nanobot technology will provide fully immersive, totally convincing virtual reality. Nanobots will take up positions in close physical proximity to every interneuronal connection coming from our senses. We already have the technology for electronic devices to communicate with neurons in both directions, yet requiring no direct physical contact with the neurons. For example, scientists at the Max Planck Institute have developed "neuron transistors" that can detect the firing of a nearby neuron, or alternatively can cause a nearby neuron to fire or suppress it from firing. This amounts to two-way communication between neurons and the electronic-based

neuron transistors.

If we want to experience real reality, the nanobots just stay in position (in the capillaries) and do nothing. If we want to enter virtual reality, they suppress all of the inputs from our actual senses and replace them with the signals that would be appropriate for the virtual environment. Your brain experiences these signals as if they came from your physical body. After all, the brain does not experience the body directly; inputs from the body—comprising a few hundred megabits per second—representing information about touch, temperature, acid levels, the movement of food, and other physical events, stream through the Lamina 1 neurons, then through the posterior ventromedial nucleus, ending up in the two insula regions of cortex. If these are coded correctly—and we will know how to

Computers arriving
at the beginning of
the next decade will
become essentially
invisible: woven
into our clothing,
embedded in
our furniture and
environment.



do that from the brain-reverse-engineering effort—your brain will experience the synthetic signals just as it would real ones. You could decide to cause your muscles and limbs to move as you normally would, but the nanobots would intercept these interneuronal signals, suppress your real limbs from moving, and instead cause your virtual limbs to move, appropriately adjusting your vestibular system and providing the appropriate movement and reorientation in the virtual environment.

The Web will provide a panoply of virtual environments to explore. Some will be re-creations of real places, others will be fanciful environments that have no counterpart in the physical world. Some, indeed, would be impossible, perhaps because they violate the laws of physics. We will be able to visit these virtual places and have any kind of interaction with other real, as well as simulated, people (of course, ultimately there won't be a clear distinction between the two), ranging from business negotiations to sensual encounters. "Virtual-reality environment designer" will be a new job description and a new art form.

Still Human?

Some observers refer to the post-Singularity period as "posthuman" and refer to the anticipation of this period as posthumanism. However, to me, being human means being part of a civilization that seeks to extend its boundaries. We are already reaching beyond our biology by rapidly gaining the tools to reprogram and augment it. If we regard a human modified with technology as no longer human, where would we draw the defining line? Is a human with a bionic heart still human? How about someone with a neurological implant? What about two neurological implants? How about someone with ten nanobots in his brain? How about 500 million nanobots? Should we establish a boundary at 650 billion nanobots: Under that, you're still human and over that, you're posthuman?

Our merger with technology has aspects of a slippery slope, but one that slides up toward greater promise, not down into Friedrich Nietzsche's abyss. Some observers refer to this merger as creating a new "species." But the whole idea of a species is a biological concept, and what we are doing is transcending biology. The transformation underlying the Singularity is not just another in a long line of steps in biological evolution. We are upending biological evolution altogether.

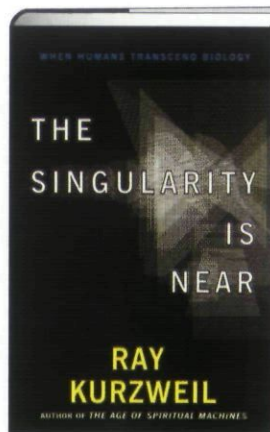
By the late 2020s, we will have completed the reverse engineering of the human brain, which will enable us to create nonbiological systems that match and exceed the complexity and subtlety of humans, including our emotional intelligence. Nonbiological entities will claim to have emotional and spiritual experiences, just as we do today. They—we—will claim to be human and to have the full range of emotional and spiritual experiences that humans claim to have. And these will not be idle claims; they will evidence the sort of rich, complex, and subtle behavior associated with such feelings.

In fact, these future machines will be even more humanlike than humans today. If that seems like a paradoxical statement,

consider that much of human thought today is petty and derivative. We marvel at Einstein's ability to conjure up the theory of general relativity from a thought experiment or Beethoven's ability to imagine symphonies that he could never hear. But these instances of human thought at its best are rare and fleeting. Our future, primarily nonbiological selves will be vastly more intelligent and so will exhibit these finer qualities of human thought to a far greater degree.

The Singularity denotes an event that will take place in the material world, the inevitable next step in the evolutionary process that started with biological evolution and has extended through human-directed technological evolution. Evolution moves toward greater complexity, greater elegance, greater knowledge, greater intelligence, greater beauty, greater creativity, and greater levels of subtle attributes such as love. In every monotheistic tradition God is likewise described as all of these qualities, only without any limitation: infinite knowledge, infinite intelligence, infinite beauty, infinite creativity, infinite love, and so on. Of course, even the accelerating growth of evolution never achieves an infinite level, but as it explodes exponentially it certainly moves rapidly in that direction. So evolution moves inexorably toward this conception of God, although never quite reaching this ideal. We can regard, therefore, the freeing of our thinking from the severe limitations of its biological form to be an essentially spiritual undertaking. ©

From the bestselling author of *The Age of Spiritual Machines*



Inventor and Futurist Ray Kurzweil presents the next stage of his provocative view of the future: **the merging of humans and machines**

"Ray Kurzweil is the best person I know at predicting the future of artificial intelligence." —BILL GATES, Chairman of Microsoft

"*Singularity* is a tour de force, imagining the unimaginable and eloquently exploring

the coming disruptive events that will alter our fundamental perspectives as significantly as did electricity and the computer."

—DEAN KAMEN, physicist, inventor, and recipient of the National Medal of Technology

AVAILABLE NOW FROM VIKING

A member of Penguin Group (USA) Inc. | www.penguin.com



Copyright of Science & Spirit is the property of Heldref Publications. The copyright in an individual article may be maintained by the author in certain cases. Content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.