Book Discussion*—Radical Evolution *by Joel Garreau

ODYSSEANS OF THE TWENTY-FIRST CENTURY

by James T. Bradley

Abstract. In his book *Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies—and What It Means to Be Human* (2005), author-journalist Joel Garreau identifies four technologies whose synergistic activity may transform humankind into a state transcending present human nature: genetic, robotic, information, and nano (GRIN) technologies. If the GRIN technologies follow Moore's Law, as information technology has done for the past four decades, *Homo sapiens* and human society may be unimaginably different before the middle of this century. But among scientists, futurists, and other pundits there is no agreement on the nature and ramifications of this transformation. Based on dozens of interviews, Garreau sees three possible scenarios for our species. The Heaven Scenario foresees enhanced bodies and minds in a disease-free world, perhaps even immortality; the Hell Scenario warns of losing our identity as a biological entity and perhaps the demise of liberal democracy; the Prevail Scenario predicts that we will muddle through the GRIN technology revolution basically intact, as we have prevailed during past technological upheavals. In this review, these scenarios are examined in the context of Kuhn's "normal" versus "extraordinary" science and in the context of current understanding about gene function.

Keywords: biotechnology; extraordinary science; Francis Fukuyama; Joel Garreau; genes; GRIN technologies; Heaven Scenario; Hell Scenario; human evolution; human nature; human values; Thomas Kuhn; Ray Kurzweil; Jaron Lanier; metaphors in science; Moore's Law; nanotechnology; normal science; Prevail Scenario; religion; spirituality; Gregory Stock; transcendence

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Radical Evolution: The Promise and Peril of Enhancing Our Minds, Our Bodies—and What It Means to Be Human. By JOEL GARREAU. New York: Broadway, [2005] 2006. 273 pages + Suggested Readings, Notes, and Index. Paper. $15.95.

Humanity is on the cusp of four technological revolutions, any one of which could usher in a Shangri-la–like era for us and the planet, launch us unstoppably toward perdition, or support development of a new and positive level of human connectedness. Joel Garreau, in his provocative *Radical Evolution*, dubs the technologies behind these revolutions the "GRIN technologies—genetic, robotic, information, and nano processes." Purposeful or inadvertent applications of GRIN technologies may alter human nature, and thereby society, for better or for worse. From genetics may come human germline genetic enhancement, age retardation, cloning, and organ regeneration; robotics and information technologies may yield machines more intelligent than humans and just as autonomous; and nanotechnology, the manipulation of matter at the atomic and molecular levels, is already used to construct materials and particles with dimensions of a few billionths of a meter and properties astonishingly different from those we encounter in everyday objects. Developments in any one of these feed advances in the others. Acting synergistically, their power for human transformation may be unmatched by all but a few former periods in humankind's sojourn on Earth.

Perhaps the most pivotal previous transformative era began some 5 million years ago when our hominid ancestors acquired an autocatalytic loop of traits—bipedalism, brain expansion, manual dexterity, an omnivorous diet, and material culture—that ultimately transformed tree-dwelling primates into artists, scientists, and philosophers, as insightfully discussed by Jeffrey McKee (2000). Garreau cites a much later transformative period for humans, identified by German philosopher Karl Jaspers as the Axial Age. This was the period of spiritual enlightenment between about 800 and 200 B.C.E. in which major religious and philosophical traditions find their roots in such figures as Socrates, Isaiah, Zoroaster, the Buddha, and Confucius. Garreau's book is not a source for religious history or for scientific information about GRIN technologies themselves; rather, its focus is on what these technologies may eventually mean for human society. The substrate upon which GRIN technologies ultimately act is human nature itself, which stands to be transformed by them. "Transformed into what?" and "How soon?" are the questions.

But first, who is Joel Garreau? He is not a scientist or a technologist but a student of global change and values. He is a reporter, editor, and cultural revolution correspondent for *The Washington Post* and has been a senior fellow at the University of California at Berkeley and at George Mason University. His two other books are *The Nine Nations of North America*

(1981), an analysis of the geopolitical-cultural structure of the continent, and *Edge City: Life on the New Frontier* (1991), about the dynamics between the American psyche and late twentieth-century growth of American cities. Garreau heads The Garreau Group, a company whose Web site describes it as a network of persons committed to "understanding who we are, how we got that way, and where we're headed, worldwide." His Garreau Group biography concludes by describing him as "the troll of a small forest in the foothills of Virginia's Blue Ridge where he lives with his wife and two daughters."

The notion that humanity is now entering a major transformative period is predicated upon the reality of The Curve, a phenomenon referring to exponential growth in the power and complexity of human technologies. Existence of The Curve for information technology was noted in 1965 by Gordon E. Moore, who observed that the complexity of "minimum cost semiconductor components" doubled about every year. Soon Moore's observation was formalized into "Moore's Law": The power of information technology will double every eighteen months into the indefinite future. Garreau reports that the power of information technology has now followed Moore's Law for nearly thirty doublings. The current Deep Blue IBM computer project aimed at producing a machine that handles a thousand trillion instructions per second may approach the processing power of the human brain. If genetics, robotics, and nanotechnology are also driven by The Curve, we and our world may be about to change rapidly, radically, and perhaps irreversibly. One gets the feeling that Garreau definitely believes all four GRIN technologies do obey The Curve, although objective data for that belief exists only for information technology. Whether the power of the latter can sustain exponential growth much longer is an open question whose answer depends upon laws of physics and technological breakthroughs at the nanoscale.

For the sake of dialogue, let us assume that advances in all GRIN technologies do obey The Curve and will continue to do so into the indefinite future. What would this mean for humankind?

"Transcendence" is Garreau's answer. We are not given one concise definition of transcendence, but Garreau does write an entire chapter titled "Transcend" in which he ponders his and others' notions of human transcendence. During an interview with Nick Bostrom, cofounder of the World Transhumanist Association, Garreau reports having asked: "When we're talking about transhumanism, we're talking about transcending human nature. . . . One notion of transcendence is that you touch the face of God. Another version of transcendence is that you become God. Does the word *transcendence* mean anything to you?" Bostrom's lengthy response is hopefully optimistic about humankind using technology to attain "higher levels of moral excellence" (p. 242). But everybody who thinks about transcendence does not emphasize morality. For example, interviewee Jaron

Lanier, computer scientist, artist, composer, and originator of the term *virtual reality*, points out that humankind's moral evolution can lead to holy wars (p. 210). I agree. What do we have now in the Middle East but clashing moral doctrines contributing to destruction and death? For Lanier, as we shall see, transcendence means heightened feelings of connection between individuals.

The nature of transcendence will depend upon the character of that which is being transcended—that is, human nature. There is no consensus anywhere, including the pages of Garreau's book, on how to define or describe human nature. But Garreau personally seems to like the view of German sociologist Justin Stagl, which he (Garreau) summarizes like this: "Our human nature may be grounded in our animal nature, but our ability and eagerness to develop our 'better nature' are unique" (p. 237). Three possible paths for society after humans transcend their present nature are imagined by Garreau: the Heaven, Hell, and Prevail Scenarios. These are developed from information obtained through interviews and by reading about the concerns, hopes, and forecasts of many talented, opinionated, and articulate persons writing and/or thinking about the GRIN technologies and the future of humankind.

Ray Kurzweil and Gregory Stock are named key spokespersons for the Heaven Scenario. Kurzweil is a computer scientist, inventor, author (*The Age of Spiritual Machines, When Computers Exceed Human Intelligence* [1999]), and entrepreneur. Stock is a developmental biologist by training. He heads the Program on Medicine, Technology and Society at UCLA's School of Medicine and a new biotechnology company in New Jersey. He is author of several books including *Redesigning Humans: Our Inevitable Genetic Future* (2002).

Kurzweil unabashedly promotes human cognitive enhancement via information technology. He views current humanity as a transient stage in the overall evolutionary history of intelligence in the universe. Over the next few decades, he predicts, our "wet brains" of neurons, synapses, and other cells and cell products will be augmented or even replaced by nonbiological computational and analytical devices. Kurzweil cites present brain implants to treat deafness and Parkinson's disease as early precursors of microscopic robots distributed by the billions throughout the brain to enhance cognition and create whatever virtual reality one desires. Kurzweil, now approaching 60, also envisions literal immortality for humans within his lifetime through the freeing of our intellect and consciousness from its mortal, biological constraints. He views the body as transient housing for the essence of an individual, the mind. When the mind can be contained in/on long-lived, nonbiological material, biological aging and senility will be irrelevant to its continued existence. "What we see in evolution," says Kurzweil, "is increasingly accelerating intelligence, beauty . . . exponentially greater love" (p. 93).

The term *singularity* is used by Kurzweil and others to speak of what GRIN technologies will ultimately mean for humanity. The term is borrowed from mathematics and physics where it refers to a function that approaches infinity or a point of infinite density and energy such as at the Big Bang, where known laws of physics break down. Garreau explains that The Singularity in human history denotes a time when technology is transforming humanity and society so rapidly that "our everyday world stops making sense . . . that's when The Curve goes almost straight up. The sheer magnitude of each doubling becomes unfathomable" (p. 72). Soon after The Singularity arrives, before 2030 according to some, robotic intelligence will equal or eclipse that of human intelligence, and meaningful communication between enhanced and unenhanced humans may be impossible. Exactly how downloading human minds onto pieces of long-lived, nonbiological material translates into increased beauty and love is not explained by Kurzweil or Garreau.

Stock also sees radical human enhancement as inevitable, not first through computer/information technology but by the genetic manipulation of our biology. Life extension, disease prevention and cures, rejuvenation of aging tissues and organs, and cognitive enhancements, he believes, will emerge from advances in and/or expanded use of existing technologies like in vitro fertilization, embryo selection, cloning, and genetic enhancement. In Garreau's Heaven Scenario, humans ultimately will use GRIN technologies to create heaven on earth—a world where disease and even death have lost their sting and where war, greed, poverty, and suffering are relics of our pre-transcendence history.

But then there is the Hell Scenario. Garreau places the ideas of computer scientist Bill Joy and author-historian Francis Fukuyama in his Hell Scenario. Joy is cofounder and former Chief Scientist of Sun Microsystems. He also cochaired the presidential commission on the future of information technology research. Fukuyama is widely published as an international political economist and social historian, Dean of Faculty at the Paul H. Nitze School of Advanced International Studies, Johns Hopkins University, and a member of the president's Council on Bioethics.

Joy is known for his 2000 article, "Why the Future Doesn't Need Us" in *Wired Magazine*, where he warns about the risks of GRIN technologies. He foresees disastrous outcomes from constructing self-replicating, biological pathogens and nonbiological products of nanotechnology that outcompete naturally evolved biological inhabitants of the biosphere. Fukuyama is mainly concerned that using modern biotechnologies such as cloning, age retardation, and genetic enhancement to alter human nature will endanger liberal democracy, a view advanced in his 2002 book *Our Posthuman Future—Consequences of the Biotechnology Revolution*. Both authors believe that further development of GRIN technologies must be restricted in order to avert ruinous results from their use.

Somewhere between Heaven and Hell is a Prevail Scenario not polarized toward optimism or pessimism. Overall, Prevail is an optimistic scenario. It views human history as an odyssey in which crises are dealt with as they arrive—sometimes successfully and sometimes unsuccessfully. It does not deny that GRIN technologies may follow The Curve, but it presumes that good decisions by ordinary people will guide humankind through difficult and confusing times as they have during earlier periods. Garreau's favorite spokesperson for Prevail is Lanier, who believes that humans can and will creatively shape the impact of technology on human nature and society to their benefit. In the Prevail future are increased and strengthened empathetic connections between individuals. Lanier refers to this increase in interpersonal connections as the "connectivity ramp" to distinguish it from exponential change associated with The Curve. In the Prevail Scenario, human will, imagination, and courage separate The Curve from its effects on society.

Even more difficult to foresee than GRIN technologies' applications to medicine, human cognition, and communication are their possible effects on religious beliefs and practices. Whether religion overall would fare differently in the Heaven, Hell, and Prevail Scenarios and whether different religious traditions would be affected differently are interesting questions addressed only cursorily by Garreau. What we do get, primarily in Chapter 7, "Transcend," is a rich potpourri of Garreau's and others' musings on human nature and how technology-driven transcendence of human nature might affect our spirituality. Here the narrative is driven more by questions than conclusions. For example, what if humans create angels out of themselves? Kurzweil predicts beings by 2099 that are indistinguishable from the Christian portrayal of angels—immortal minds in nonphysical bodies that can be projected as real or virtual matter at will (p. 104). In religious systems where immortality and perfection are characteristics of God that distinguish us from God, how would humans' approaching immortality and perfection on Earth, through their own cleverness, be received?

Another question is whether genetic, pharmaceutical, or electronic manipulations will ever be able to remove religion as an essential human need. Garreau reports that history-of-religion author Karen Armstrong believes that humans are hardwired for religion (p. 259). She is not alone. That religion has biological roots is the thesis of at least two relatively recent books—*Why God Won't Go Away* (Newberg, d'Aquili, and Rause 2001) and *The God Gene* (Hamer 2004). If the need for religion is based on "a universal search for meaning and values" or an inability to "endure emptiness and desolation" (Armstrong, cited by Garreau, p. 259), is this need something we ought to change about our human nature?

What about Lanier's "connectivity ramp" and spirituality? Martin E. P. Seligman, president of the American Psychological Association, says that a

meaningful life "consists in attachment to something bigger than you are" (p. 261). Whether being part of a large, diverse, compassionate, intimately connected group of people, as envisioned by Lanier, could itself provide meaning in ways currently provided by religion will remain unknown until the "connectivity ramp" has touched most of us in ways that, in my view, must be qualitatively different from the ways cellular phones, iPods, and Blackberries do now. Lanier himself embraces a healthy agnosticism when it comes to spirituality: "For a lot of these questions, I think 'I don't know' is the most dignified and profound answer." He leaves open the possibility that "the world we manipulate here isn't all there is. The world accessible by technologies isn't all there is" (p. 199).

So what are we to make of Garreau's book, his selection of interviewees, their predictions, and the future of human nature? Garreau is a talented writer. He has created an engaging narrative from an extraordinarily diverse pool of views and information gained from interviews and writings of dozens of persons. The categories of Heaven, Hell, and Prevail undoubtedly oversimplify a real future revolutionized by GRIN technologies, but they serve well for organizing his narration and helping readers unfamiliar with GRIN technologies to order their thinking about them. Still, as a scientist and as a biologist, I should like to warn non–science-trained readers of *Radical Evolution* about two things: the unspectacular nature of "normal science," and the misunderstood gene.

"Normal science" is Thomas Kuhn's term for the process of scientific discovery occurring between scientific revolutions (1970, 10–11). Normal science is performed working within a paradigm for the discipline—a set of premises about the way nature behaves. Periodically, observations that do not fit neatly into the current paradigm induce a crisis for the discipline that usually can be resolved by further or more careful experimentation but that occasionally forces a paradigm shift, that is, a scientific revolution (1970, 86–91). The twentieth-century transition in physics from a Newtonian viewpoint to a relativistic one is a classic example of a Kuhnian paradigm shift. Only a small number of scientists throughout history have been directly engaged in the "extraordinary science" that causes a paradigm shift—for example, Copernicus, Galileo, Einstein, Bohr, Heisenberg, Watson, and Crick. By contrast, in every generation hundreds of thousands of researchers at universities and in industry throughout the world spend their professional careers doing "normal science"—toiling away at their laboratory benches every day to provide, bit by painstaking bit, basic information that ultimately becomes interpreted for general audiences by journalists and other writers such as Garreau and most of his many sources.

With a few exceptions like Stock, whose professional career has included top-notch academic research and discovery, Garreau's sources do not include scientists working in the trenches of normal science. Trench workers, largely unknown by journalists and the general public, are named as authors in

the tables of contents of scientific periodicals including *Science*, *Nature*, *Cell*, *Proceedings of the National Academy of Sciences of the United States of America*, *Chemical Engineering Science*, *Nanotechnology*, *Journal of Physical Chemistry*, and *Industrial and Engineering Chemistry Research*. These are the persons with intimate knowledge about the expense, time, effort, careers, and collaborations it usually takes to obtain even modestly significant discoveries, not to mention the time and complexities involved in clinical trials and gaining federal approval before new materials or practices are offered to the public. In my view, these are also the persons to interview for realistic insights into feasibility and time-frame estimations for realizing fruits of GRIN technologies.

Had *Radical Evolution* included the views of trench workers on such subjects as human limb regeneration, organ farming, tissue repair and rejuvenation by micro-robots, human minds freed from biological constraints, strong artificial intelligence, and virtual human immortality, would readers finish the book with a different impression about humankind's future in this century than they do now? I suspect so. Most readers' views about the future, I believe, would be less radical. Transcendence of our present nature, whatever that nature is, will evolve gradually as an accumulation of nearly imperceptible changes rather than pouncing upon us as a shocking revolution. At least that is what I foresee for genetic and cellular-based technologies, those which I am most qualified to comment upon.

In addition to the laborious nature of normal science, widespread misconceptions about gene function are also bases for tempering expectations for transformative, biologically based changes to human nature. French molecular biologist and historian of science Michael Morange wrote about the misunderstood gene ([1998] 2001). According to Morange, weaknesses in metaphors that have long been used to describe genes have engendered misunderstandings in the public and within a generation of scientists that has not experienced the historicity of the metaphors.

Until completion of the Human Genome Project in 2001, it may not have mattered much whether one thought of an organism's genes as a book, blueprint, or computer program. But now metaphors matter more because they powerfully influence payoff expectations from genomics. Metaphor-driven expectations usually overlook realities of the complexities of gene function and expression. For example, the book and blueprint metaphors falsely elevate the importance of genes above other cellular components. The computer-program metaphor does the same by implying that the program (DNA) commands the behavior of subservient proteins and that progressive development of an organism can be understood by decoding its genes. Views like this ignore the critical and complex interplay between proteins, cells, and their environment during development. Corollaries to metaphors placing genes at the apex of a regulatory pyramid of determinative events and elements include the belief that genomic information will

be rapidly translated into cures for multitudinous genetic diseases and other human biological enhancements.

Morange has detailed how gene knockout experiments in mice reveal our ignorance about gene function (2001, 64–82). Inactivating genes with known, vital functions often produce no observable defects in the mouse. This surprising result probably arises from one or more phenomena including functional gene redundancy and gene compensation—that is, other unidentified genes taking over the function of the knockout gene. In other experiments, knocking out a single gene with a single known function produces unexpected structural or physiological changes seemingly unrelated to the known function of the gene. Possible explanations include the existence of complex networks of interdependent gene products and hierarchical structures in which the activity of a gene product depends on the action of many other gene products that create ordered, organic environments radiating outward with increasing complexity. The upshot is that, with a few exceptions, adding, altering, or deleting one or a few genes is not a safe or realistic approach to curing disease or enhancing specific biological attributes in the foreseeable future.

Working to increase our presently limited knowledge about the function of specific gene products and their interactions with other gene products is the field of proteomics, a relatively new subdiscipline of molecular biology. Proteomics, which examines the structure, occurrence, and function of networks of protein-protein interactions, will someday make possible an era of prudent, positive eugenics through human genetic engineering. Although I doubt that this will happen very soon, I agree with Stock and paleontologist/evolutionary biologist George Gaylord Simpson that, ultimately, human genetic enhancement is inevitable. Simpson's words reflect the care and humility with which the project must be undertaken:

> I am pretty sure that if we survive, if we do not destroy ourselves with pollution, atomic war, and so on, we will sooner or later wish to take control of our own evolution. But I hope we do not do it too soon. I mean, at the moment we are far too ignorant, both of genetics and of what we really want, to tinker with our own evolution. So I'm not urging eugenic measures upon us. I'm really not. I hope we will not do that. But ultimately I'm sure we will. What we shall decide we want, of course, is up to our great great great grandchildren. But they will take this on. (Simpson 1993)

What Garreau has given us with *Radical Evolution* is a heads-up on what our distant descendants may be dealing with. What we must do now is keep the ethical and societal issues engendered by the GRIN technologies before our children and grandchildren so that they and their descendants will have tools for making wise choices about our species' future. One way of doing this is to formalize study of the science/technology–ethics interface in public education. In the United States, government institutions

have stepped to the plate in this area with such programs as the ELSI (Ethical, Legal, and Social Implications) component of the Human Genome Project, funded by the Department of Energy and the National Institutes of Health, and National Science Foundation Programs including Nanotechnology Undergraduate Education and Ethics Education in Science and Engineering. Individual parents and teachers must commit similarly to self-education and teaching.

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