NANOVISION

ENGINEERING THE FUTURE

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> We have technology to manipulate matter right down to the molecular level. This is an extraordinary ability, think of it! And yet some of us here can accept transforming the entire physical reality of this planet, without doing a single thing to change ourselves, or the way we live. . . . And so I say that among the many things we transform on [this planet], ourselves and our social reality should be among them. We must terraform . . . ourselves.
> —Kim Stanley Robinson, *Red Mars*

Like the future itself, this book has been a while in the making. My fascination with the dawning era of nanotechnology began during the mid-1990s, and in the intervening years my thinking on the topic of the very, very small has benefited enormously from conversations with many friends and colleagues about science, fiction, and the absolute weirdness of the shape of things to come. The terraforming of the self begins with such conversations, in the interface.

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INTRODUCTION

THE SINGULARITY OF NANOVISION

> Additional view-windows kept popping up as the nanomachines multiplied. . . . Only a minute had elapsed, but the world felt different. Human history had changed for good.
> —Rudy Rucker, *Postsingular*

> The universe grows smaller every day.
> —*The Day the Earth Stood Still*

It's coming. Or rather . . . it's here.

In 1993, the mathematician, computer scientist, and science fiction writer Vernor Vinge prophesied the end of human history. Once again. It's the end of the world as we know it . . . and not for the first time. So this would appear to be nothing new. And yet . . .

Looking at the rapid acceleration of technological progress over the course of the twentieth century, Vinge observed an exponential growth curve in the development of computational systems, bioengineering capabilities, human-hardware interfaces, and machinic intelligence, all of which seemed to suggest that a cataclysmic takeoff of technological complexity would likely occur sometime between 2005 and 2030. The growth curve of technoscientific progress would rise asymptotically toward infinity, and nothing would thereafter remain the same. Vinge termed this point in the future "the Singularity." The impact of these technoscientific changes on human society would be so overwhelming as to constitute not simply a new era in history but the onset of a new reality entirely, a new mode of being. The Singularity, Vinge writes, will be "a point where our old models must

be discarded and a new reality rules, a point that will loom vaster and vaster over human affairs until the notion becomes a commonplace. Yet when it finally happens, it may still be a great surprise and a greater unknown." Indeed, before we are perhaps even aware of it, "we will be in the Posthuman era."[1]

This idea of "singularity" comes from mathematics and astrophysics, where it indicates the point at which a function rockets to infinite value, or where the fabric of space-time collapses to a point of infinite curvature, such as general relativity predicts will occur inside a black hole. Within a space-time singularity, the established rules of physics no longer apply; as the physicist Stephen Hawking puts it, "At the singularity, general relativity and all other physical laws would break down: one couldn't predict what will come out of the singularity."[2] In adapting this scientific concept for futurological purposes, Vinge came to understand the technological Singularity as an "edge of change" in human evolution, marking our entry into "a regime as radically different from our human past as we humans are from the lower animals. This change will be a throwing-away of all the human rules, perhaps in the blink of an eye—an exponential runaway beyond any hope of control" ("TS," 89). The human species would transform so utterly during the Singularity as to be alien from its current condition.[3] But understanding the nature of this change, or the features of this new "regime," would be prevented by the very acceleration of the change itself. Because the Singularity "involves an intellectual runaway, it will occur faster than any technical revolution seen so far" ("TS," 90). In the same way that a singularity in a mathematical function blocks extrapolation of the curve beyond the point where it shoots upward toward infinity, or that a black-hole singularity in space traps light and prevents us from seeing beyond its event horizon, the technological Singularity blocks our ability to see the future. It cannot be extrapolated by past experience or by scrutinizing current tends; it remains "unseen" precisely because it is so different from any other era of technological change that has been "seen so far."

The very question of seeing is as much at stake in the technological Singularity as it is in the astrophysical singularity of the black hole, for they are both points of blindness where the human conceptual apparatus—dependent, at least metaphorically, on light, sight, and vision—cannot penetrate. According to Vinge, the Singularity is a moment of darkness, a point that occurs "in the blink of an eye," a spot in time where we literally cannot see. Those who try to rigorously understand the consequences of technological change for human culture—such as science fiction writers and futurolo-

gists—increasingly find their visionary abilities curtailed by the "unknown" of the Singularity, their speculations sent careening asymptotically in multiple directions at the event horizon of this black hole in history. The Singularity blocks prediction and visionary speculation; it is "an opaque wall across the future" ("TS," 90). Consequently, from this side of the Singularity, even the "most diligent extrapolations [have] resulted in the unknowable" (90). The Singularity becomes a pure event, cleanly separating the past from the future, a cleavage "that we cannot prevent," for "its coming is an inevitable consequence of humans' natural competitiveness and the possibilities inherent in technology" (92). And because we cannot see beyond this inevitable transformative event, all we can know is "how essentially strange and different the Posthuman era will be" (95).

Vinge's own fictional efforts to characterize the technological events surrounding the Singularity repeatedly evaporate into mystery.[4] The characters in his novel *Marooned in Realtime* (1986), for example, travel in temporal suspension to a historical point after the Singularity has already occurred—essentially, they unwittingly sleep through the Singularity. The sleepers wake to discover Earth's human population and all its technological traces vanished. No amount of study will reveal the truth of the disappearance, the nature of Singularity. It is a pure point of undecidability. Assembling pieces of historical evidence from before and after this void in time, the characters' best guess is that "humankind and its machines became something better, something . . . unknowable." But "if technology had transcended the intelligible [and] . . . if minds had found immortality by growing forever past the human horizon," then this "human horizon" would itself mark the limit of specularity and speculation. The limit of the intelligible functions, therefore, as a mirror: "The Singularity was a mirrored thing."[5] Looking at it, speculating on it, only reflects the human past back to itself: alternative futures remain invisible, veiled by the mirror. We are blind to the beyond.

Scientific and philosophical dialogues about the Singularity have repeatedly emphasized this characteristic blindness. The critical theorist Damien Broderick describes the onrushing rapid acceleration of machine intelligence as "the edge of a technological Singularity, the place when the future starts to go completely opaque." Once we pass the edge, the "future is going to be a fast, wild ride into strangeness," slipping by in "(historically speaking) the blink of an eye."[6] This opaque, estranging future that meets us suddenly when our eyes are closed appears as a violent scission, a slicing of time by the cutting edge of complexity. With an ironic wink to millenarian clichés, the computer scientist Ray Kurzweil has announced that "the Sin-

gularity is near,"[7] and he insists that we are coming upon this cutting edge sooner than we think: "We are entering a new era. I call it 'the Singularity.' It's a merger between human intelligence and machine intelligence that is going to create something bigger than itself. It's the cutting edge of evolution on our planet."[8] This cutting edge makes a break in history, a division that separates our knowable past from the impossibly strange future, as if rupturing or puncturing our very eyes as they peer into the distance.

Hans Moravec—a roboticist well known for his prognostications on the evolution of machine intelligence and the theory of "uploading," or the transference of human mind into computer code[9]—has written: "If there is a singularity, it's kind of natural to divide time into BS (the negative times before the singularity) and AS (the strange times afterwards)."[10] Our living history recedes into absolute negativity (or, indeed, into "BS") relative to the force of the unknown future, whose strangeness is mathematically infinite and is perceived thus as an absolute positivity. It is as if this singular blade has already fallen onto the Cartesian grid of human temporal existence, just ahead of us, but also just out of sight, for we would seem to have already dropped into the abyss of obsolescence, erased by a future fundamentally outside our peripheral vision. Indeed, as the physicist and science fiction writer Gregory Benford suggests, most of us will never see the Singularity; we won't be aware of it even when it arrives, for while some sectors of humanity will whisk across this transition, most will never *see* it happening because "those in the Singularity will be beyond view, anyway."[11]

Max More, a transhuman theorist and founder of the futurological Extropy Institute, suggests that various scenarios for massive technical change are possible. Some indicate radical severance and discontinuity, others promise a rapid but continuous burst into strangeness, but all find the future imperceptible from within our stygian hole of mere humanity:

> This Singularity includes the notion of a "wall" or "prediction horizon"—a time horizon beyond which we can no longer say anything useful about the future. The pace of change is so rapid and deep that our human minds cannot sensibly conceive of life post-Singularity. Many regard this as a specific point in the future, sometimes estimated at around 2035 when AI and nanotechnology are projected to be in full force. . . . The more that progress accelerates, the shorter the distance measured in years that we may see ahead. . . . Singularity [can also be] seen as a *surge* into a transhuman and posthuman era. . . . In Singularity as Surge the rate of change need not remotely approach infinity. . . . It would be a historically brief

> phase transition from the human condition to a posthuman condition of agelessness, super-intelligence, and physical, intellectual, and emotional self-sculpting. This dramatic phase transition, while not mathematically instantaneous, will mean an unprecedented break from the past. Second, since the posthuman condition (itself continually evolving) will be so radically different from human life, it will likely be largely if not completely incomprehensible to humans as we are today.[12]

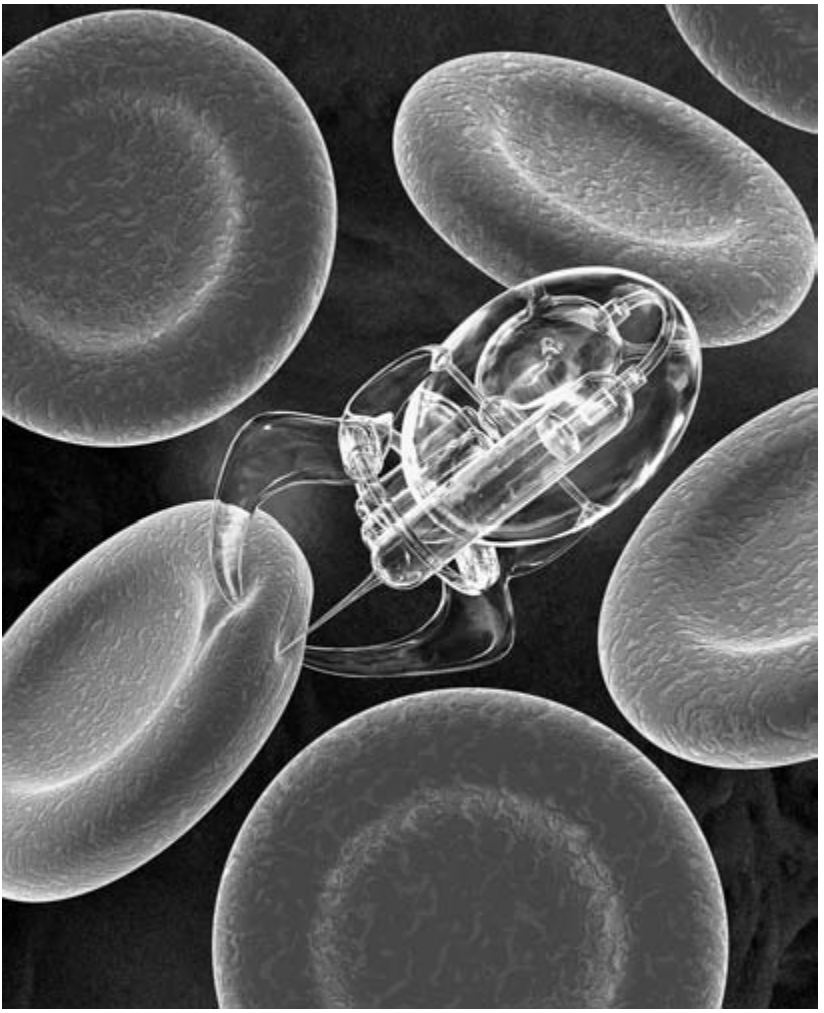
The envisioned Singularity, whether characterized as a "wall" or a "surge," remains a decisive event that divides history itself so cleanly, so cataclysmically, that what we know as "the human" cannot see past its own closure. It is a failure of humanism itself. As Vinge writes, "The problem is not simply that Singularity represents the passing of humankind from center stage, but that it contradicts our most deeply held notions of being" ("TS," 94).

We cannot see past the Singularity because to do so would involve an entirely different way of seeing, a new epistemological orientation toward the world, a new thinking of being that is no longer the perspective of the human, but instead that of the posthuman, the postbiological, the machinic, the cyborg, the networked, the uploaded, the synthetic, the schizophrenic, the alien, the monstrous, the wired, and the weird. Outside the spaces delineated by humanist sensory capabilities, this technologically involved perspective of radical alterity, as N. Katherine Hayles has written, would see "no essential differences or absolute demarcations between bodily existence and computer simulation, cybernetic mechanism and biological organism, robot teleology and human goals."[13] Precisely because the Singularity, or "the Spike," as Broderick prefers to call it, "could change everything utterly, in ways too ruinous and horrifying to regard with merely human gaze," we require other forms of perception unhampered by epistemic limitations of the visible or intelligible.[14] Indeed, the only way to see through the looking glass, the only way to glimpse the posthuman future across the opposite side of the wall, would be to render the stasis of human vision into perceptual motion, through the active involvement of the observant body in technological events, in a real physical passage through and across the singular limits of knowledge. Travel or tunnel through, or carry across in a surge, as Vinge tells us, and "then it's *you* . . . who will understand the Singularity in the only possible way—by living through it."[15] Amazingly enough, it turns out that the technological events through which we might involve ourselves bodily and intelligibly in this "living through" of the invisible future are already at hand.

Among all the technoscientific developments invoked by theorists of Singularity as components in the technological eventstream leading inexorably toward the altered reality of the posthuman era—including artificial superintelligence, genetic engineering, artificial life, evolutionary robotics, cloning, synthetic biology, and ubiquitous computing—perhaps none has seemed as prominent or as promising as nanotechnology. Nanotechnology is the engineering of material structures and functional systems at the scale of nanometers (billionths of a meter), where individual molecules and atoms become objects of manipulation. Nanotechnology strives to take advantage of unique properties of matter at this molecular scale, for example, the phenomenon of "quantum entanglement" that might enable quantum computing technologies, or likewise the hypothetical phase state of "machine-phase matter," whose volume would be filled entirely with active molecular machinery.[16] Nanotechnology also hopes to develop assembly processes for manufacturing microscale and even macroscale structures "from the bottom up," making conductive materials, motors, biomimetic organelles, and computational processors—even sophisticated robotic systems (figure 1)—by maneuvering individual atoms. In other words, nanotechnology dreams of engineering every aspect of our material reality, precisely fashioned and designed at the limits of fabrication, one atom at a time.

The possibilities opened by the capability to restructure and rearrange matter at the nanoscale are immense, making speculation on the future an almost inherent aspect of thinking about nanotechnology in the first place. For if nanotechnology enables us to program matter as we would program software, then the world itself can be transformed, our lived realities made completely malleable, guaranteeing that the future will be radically and immeasurably different from the present. While the precise nature of this incomprehensible difference remains to be seen, or lived through, according to Singularity theorists, it is already evident that simply by peering into the resources and capabilities of nanotechnology, we suddenly find ourselves "accelerating into a future that's literally beyond today's imagination because its complex weaving of the known and the as-yet-unknowable evades the best calculations we can make." So ready or not, "Nano will take us, will *fling* us, into the Spike."[17]

Nanotechnology as an emergent technoscientific field is actively and rapidly developing across multiple scientific disciplines, from chemistry, physics, and biology to computer science, materials engineering, and systems theory. It is a fundamentally multidisciplinary endeavor that draws its research techniques, theoretical approaches, and laboratory apparatus from



1. "Nanoprobe" (2002), by Coneyl Jay. A diamondoid syringe-bot travels through the body, delivering drugs to red blood cells. Originally entitled "Nanotechnology," this conceptual image received the Visions of Science Award in 2002 (sponsored by the *Daily Telegraph* and the pharmaceutical company Novartis). © Coneyl Jay/Photo Researchers, Inc. Reproduced with permission.

many different traditions and regions of scientific specialization.[18] Its possibilities are being explored both experimentally and speculatively across academia, industry, and popular culture. The term "nano-technology" first appeared in a 1974 article by Norio Taniguchi, a professor at the Tokyo Science University, although the conceptual origins of the field have often been traced to the hopeful prognostications of the Nobel Prize–winning physicist Richard Feynman in the late 1950s.[19] Yet nanotechnology only fully emerged as a research program with monumental implications for the human future in the writings of K. Eric Drexler during the 1980s and 1990s. Along with his several important technical articles and monographs, Drexler's *Engines of Creation: The Coming Era of Nanotechnology* (1986) inspired legions of scientists and techno-enthusiasts with the feasibility and the consequences of developing this new science. Drexler's writings offered a grand picture of the future dramatically transformed by the advent of nanotechnology, even predicting something very like a Singularity in the wake of mature molecular manufacturing. Drexler's books drew widespread public attention to the possibility of nanoscale engineering, which for many years, and even until recently, was considered mere "science fiction" by many in the scientific community.

Since the 1980s, nanoscience has exploded across the world, attracting researchers from surprisingly different disciplinary backgrounds and from multiple technoscientific sectors. Ambitious legislation and funds for large-scale nanotechnology initiatives have recently been put in place by the governments of the United States, the European Union, Japan, the United Kingdom, China, Singapore, and many other countries. Large technology corporations and smaller start-up companies have announced nanotech R&D efforts, anticipating consumer products with "nano inside" sometime in the very near future. Already the prefix "nano" pops up all over popular culture. Television programs, novels, films, advertisements, comic books, and video games depicting nanotechnology and its implications appear nearly every day. The international hipness of nano even spills over to businesses that have little to do with the nanoscale as such (figures 2 and 3).

Nanotechnology, the science of the very small, has clearly become "big science." And though many of the research programs in academia, industry, medicine, and the military that make up the technoscapes of nanotechnology actively disavow any connection to the futurist imaginings of Drexler and his kindred "exploratory engineers"[20]—indeed, some nanoscientists have stridently suggested that Drexler's ideas about nanotechnology are not only impossible but dangerously misleading—it is nevertheless the case that

virtually all sectors of nanotechnology research strongly maintain that the technical ability to manipulate, program, and engineer matter at the molecular level heralds staggering and unprecedented transformations for our world.[21]

The scientific agencies of the U.S. government foresee the development of nanotechnology leading to "the next industrial revolution," a massive "technological convergence" at the nanoscale that will restructure both the international economy and the human body itself.[22] The nanoscientist and Nobel laureate Richard Smalley has said, "There is a growing sense in the scientific and technical community that we are about to enter a golden new era. We are about to be able to build things that work on the smallest possible length scales, atom by atom, with the ultimate level of finesse. These little nanothings, and the technology that assembles and manipulates them—nanotechnology—will revolutionize our industries and our lives."[23] Everywhere we are told that nanotechnology is "the next big idea," and we are advised of "the big changes coming from the inconceivably small."[24] The world appears to tremble under the pressure of all this expectation, and our global societies are perched on the brink of immense technological revolution by virtue of all this hyperbolic rhetoric, this inflated "nano-hype."[25] Something REALLY BIG is on the horizon, largely unseen and essentially inconceivable, but do not doubt that it is coming.

Within this action-packed, adrenaline-pumping discourse of profound, cataclysmic, unprecedented transformations that could arise as direct consequences of nanotechnology, the Singularity seems to hover in the background as their culmination. Indeed, the very conditionality of these possible changes, this question of the "could," actually locates a conceptual singularity inside nanodiscourse itself. The very possibility that nanotechnology could change the world is a subjunctivity presenting itself as the event horizon of the unseen future, as the proximal limit of a future that cannot be known other than in its radical difference from what is present. This subjunctivity is a blinding, an incisive wound, made by the cutting edge of nanotechnological research as an internal and inherent feature of thinking the possibilities of nanotechnology.

As Mark Gubrud, a researcher in quantum computing, has said, "The concept of a singularity follows directly from the original concepts of molecular nanotechnology."[26] The imagination of nanotechnology would suggest a nearly infinite number of alternate futures made available by the ability to rebuild reality from the bottom up, one atom at a time—a superposition of futures emergent from all conceivable reconstructions of any

2. Apple iPod nano: "Impossibly Small." Although Apple's petite media player is far from nanoscale, its phenomenal market success has further escalated cultural enthusiasm for the prefix "nano." As this magazine ad from November 2005 implies, nano is now practically at our fingertips, within our grasp, and we touch the "impossible."

given material assemblage—defying our abilities of prediction and making the future increasingly uncertain with every advance toward actually achieving a mature nanotechnology. Moreover, given the possibility of molecular manufacturing, the geometric or exponential acceleration of technological complexity seems *already inevitable*. Several nanotech theorists have argued that as soon as nanotechnology begins to seem possible, its continued development becomes unavoidable because a technological imperative takes over beyond human control.[27] This technological imperative would drive us insistently to a moment in the future beyond which we cannot see—the blind spot of Singularity—owing to our physical and conceptual limitations relative to our own rapidly developing technology. As Gubrud puts it, once you have nanotechnology, "that could lead to a singularity, because the rate

of technological progress would be set by technology, rather than the speed at which people work. . . . We are facing in the next few decades a time of very great technological change, primarily driven by nanotechnology and microelectronics."[28] According to the nanotheorist and science fiction writer John Robert Marlow, nanotechnology bears forth "the sound of inevitability" because so many industrial, corporate, military, governmental, economic, cultural, and scientific incentives already exist for its continued progress: "Given all of this—can nanotechnology *not* happen?"[29]

Nanotechnology thus becomes the most recent in a long assembly line of mechanical developments—from the factory system to cybernetics to AI—envisaged to become autonomous and self-evolving, driving the modern era through an uncontrollable technological determinism.[30] This sense that technology sets the pace of its own development therefore undergirds the rolling road to Singularity, for Vinge writes that advances in technological automation are so attractive on every level of social organization—domestic, industrial, artistic, economic, military, and so forth—that our progress toward a moment when "greater-than-human intelligence drives progress" is already destined, we have already lost ourselves to the acceleration, and

3. "Nano Energy Underclothes." In the streets of Hong Kong, a 2006 billboard displays the mysterious pleasures of "nano energy," the intimate and invigorating touch of the infinitesimal against the skin. Photograph by Richard Vine. Reproduced with permission.

there is no slowing down: "If the technological Singularity can happen, it will" ("TS," 89, 91).

It would seem, then, that we are inevitably made aware of Vinge's "opaque wall over the future" as an immediate consequence of thinking nanotechnology. In other words, the imagination of nanotechnology itself constructs this wall as its own internal limit, discovering that its potential is so imperative that a nanotechnology future is rendered already inevitable, but also that its potential is so vast that a nanotechnology future is rendered equally uncertain and indeterminate. The imagination of nanotechnology creates its own blindness, credited with an ability to change the future so utterly as to make that future unimaginable within the limits of human perception. We are blinded by our own efforts to conceive "the big changes coming from the inconceivably small." The Singularity appears as the edge of nanotechnological speculation, the barrier across which the present cannot cross, or even see.

And yet, paradoxically, some theorists simultaneously credit the imagination of nanotechnology with a visionary perspicacity that surpasses the blind spot of the Singularity. Kurzweil has written that "we cannot easily see inside the event horizon with certainty. . . . Nevertheless, just as we can draw conclusions about the nature of black holes through our conceptual thinking, despite never having actually been inside one, our thinking today is powerful enough to have meaningful insights into the implications of the Singularity."[31] Indeed, such impossible insights seem to be made possible by the conception of nanotechnology and its kindred fields at the cutting edge of science. Our thinking today is rendered powerfully and prophetically insightful by virtue of the rapid convergence of numerous technosciences at the nanoscale, the momentous conflation of biotech, cognotech, infotech, and more under the blooming sign of "nanotechnology."[32] The theorists, futurologists, scientists, and science fiction writers who situate their gaze within the parameters of a nanotechnological way of seeing may encounter a singular wall over the future—a black hole, a constrictive passageway, or a surge into the future that lets no light escape—but in encountering it, these visionaries see through it. Which is to say that in seeing the molecular world—or rather, the nanoworld—we now also see the nanofuture: "What [nanotech] did . . . was shatter the event horizon."[33]

At the very moment of describing the opacity of the Singularity, Vinge writes that the advent of nanotechnology simultaneously "provided spectacular insights about how far technical improvement may go" ("TS," 91). The thinking of nanotechnology provides surprising visions—"spectacular

insights"—penetrating glances into the smallest limits of molecular space that therefore open out the reaches of the future. Peering inward, they extend to the lengths of the possible ("how far technical improvement may go"). These visions into nanotechnology itself, these "insights" that see out through the far technological future—these openings across the Singularity as bursts of internal visibility that make "spectacles" of themselves—enable us to see in their being seen; they provide us with visionary enhancement precisely because they extend our limited sensorium across a techno-theoretical prosthesis, a conceptual pair of nanotech goggles or spectacles. Spectacular insights provided by nanotechnological thinking thus extend our ability to think nanotechnologically, inward and outward, across the limit of technological development. As Yoshio Nishi, a director of the Stanford University Nanofabrication Facility, puts it: "Nanotechnology is the tunnel we can take to get past that barrier. . . . There will be many engineering challenges but the path is there and we just need to keep following it. This is not science fiction."[34] The insights of nanotechnology in some way thus evade the opacity of the Singularity. Looking into itself, nanotechnology looks outward from blindness—and sees otherwise.

Nanotechnology entails a way of seeing, a perspectival orientation to the world, that operates through a productive dynamic of blindness and insight.[35] It produces a blind spot, a wall, a veil, a black hole, or a barrier and therein discovers a scission—between present and future, between human and posthuman, between science and science fiction. But at the same time, even in discovering its own blindness, it sees through it toward the beyond. It breaches the wall, breaks the barrier, lifts the veil, and voyages into the black hole. It is a way of seeing that lyses the membrane between the technological present and the nanotechnological future.[36]

I call it *nanovision*.

By tracing the cultural history of nanotechnology and examining its rhetorical, textual, and imaging practices, by looking at the structure of nanotechnological experimentation in both science and fiction, this book puts forward a theory of nanovision as a seriated movement of specularity and speculation that organizes the technoscapes and dreamscapes of nanotechnology. Nanovision is a perceptual apparatus endemic to the era of nanotechnology, atomizing our world only to perform its molecular reconstruction, envisioning ultimate limits only to speculate on their outside, fabricating barriers only to tunnel through them, projecting opaque walls only to find in the very project an excuse or an opening for spectacular insight. Through engineering a series of epistemic and rhetorical dichotomies within its

discursive domain and simultaneously rupturing their conceptual separations—the dialectics of nanovision—nanotechnology makes a radically different future possible even now. For within its assemblages of texts, images, narratives, technical artifacts, and scientific instruments, nanotechnology gives rise to this way of seeing that makes the otherwise unthinkable exterior of Singularity—the end of technological advancement from the perspective of human history—available to our imagination.

Which is not to say that nanovision simply escapes or disappears into the posthuman future; on the contrary, as we will see, nanovision depends on animating a productive dialogue and conflict between presentism and futurism, between humanistic thought and its other. But in negotiating between the conflictual elements of its own discourse, nanovision sees its blindness and therein discovers traces of alterity. In noticing its own internal singularities—or in discovering the Singularity proper—it opens to unknowable futures, brings those futures of endless possibility into the present, and thereby builds the epistemological conditions for inhabiting the future as such. It does not escape, but it opens to its beyond.

This produces a ceaseless back-and-forth motion, a sort of Fort/Da game of speculation and recall simulating the surface tension between inside and outside; and even when extending lines of flight from within the enclosed worldview of contemporary technoculture, nanovision retains certain limitations of its present condition. Its blindnesses are those of humanism and human perspectivalism more generally. Jettisoning itself from linear history and seeing the present retrospectively and already nostalgically from the perspective of the future, nanovision would seem to be a profoundly postmodern development. But at the same time, its anterior knowledge of the future depends on its technological determinism, its insistent echo of the "sound of inevitability." It evidently enacts a grand teleological narrative of future history that appears retrenchant in the face of postmodernity's notorious "incredulity toward metanarratives."[37] For in discovering the Singularity, nanovision appears to replicate a humanist and even religious teleology of the "end of man," the eschatology of the world and the apocalyptic transcendence of being.[38] Appropriately, then, the Singularity has been termed the "theology of the ejector seat" and "the rapture of the geeks."[39]

But even in animating this confrontation between humanist and posthumanist metaphysics at the site of the Singularity, nanovision discovers its own blindness and works through it, deconstructing and reconstructing the historical and metaphysical framework on which it depends. Nanovision encounters the paradox of announcing simultaneously the unknowability

of the future and the inevitability of the future, and within this paradox it unfolds an endless process of transverse movement that does not escape but manages, in motion and action, in the involvement of human perception with technological otherness, to replace the static being of transcendent "rapture" with the participatory evolution of "becoming."[40] Max More has written of precisely this issue:

> As the near-universal prevalence of religious beliefs testifies, humans tend to attach themselves, without rational thought, to belief systems that promise some form of salvation, heaven, paradise, or nirvana. In the Western world, especially in millenarian Christianity, millions are attracted to the notion of sudden salvation and of a "rapture" in which the saved are taken away to a better place. . . . I am concerned that the Singularity concept is equally prone to being hijacked by this memeset. This danger especially arises if the Singularity is thought of as occurring at a specific point in time, and even more if it is seen as an *inevitable* result of the work of others. I fear that many otherwise rational people will be tempted to see the Singularity as a form of salvation, making personal responsibility for the future unnecessary. . . . Clearly this abdication of personal responsibility is not inherent in the Singularity concept. . . . I think those of us who speak of the Singularity should be wary of this risk if we value critical thought and personal responsibility.[41]

Observing the Singularity through something like a critical nanovision, More finds the posthuman "memeset" ripe for being "hijacked" by the memeset of rapturous religiosity—if, indeed, it has not always already been deeply inhabited by this theological structure. Discovering, then, the very limitations of seeing the Singularity through humanist eyes, More advocates "critical thinking," an insistent self-reflection and analysis, and a location of visionary perspective into the self, a refusal of seeing the technological Singularity or the nanofuture as the "*inevitable* result of the work of others," but rather as the concentrated involvement of ourselves in the technocultural process of becoming-posthuman. He does not blithely jump into the post-Singularity future, despite his evident desire to do so, but instead recognizes this very temptation and veers off, using this insight to propose a participatory making of the future—indeed, a "responsible" engineering of the future. Unlike a rapturous humanism where the body can so easily be discarded, nanovision would be located within the self, within the body, within "personal responsibility" as a perceptual and responsive engagement in becoming.[42] As Wil McCarthy puts it in his science fiction novel about

nanotechnological singularity, *Bloom* (1998): "We can't ask things to happen by themselves; vision is transmuted to physicality through our hands, only."[43]

Nanovision thus performs a "techno-deconstruction" of the very structures of thought and embodiment through which it has come into being. By this I mean it challenges, questions, and revises the limits of human being at the level of metaphysics and imagination, as well as the level of corporeal materiality. For example, in Ben Templesmith's graphic novel *Singularity 7* (2005), the world is taken over and molecularly reengineered by a plague of alien nanotechnology: "They called it 'The Great Unravelling.' 4 billion people disassembled on a molecular level by the very air, swarming with nanites they simply breathed in. . . . Some that were left . . . they tried to fight back. But it was useless. How do you fight something that is in the very air? That deconstructs you on a molecular level?"[44] More than metaphor, this description perfectly condenses nanotechnology as a conceptual apparatus and a technical system of artifacts and instruments. Nanotechnology is "something that is in the very air." It swarms in the air even now; it infiltrates the zeitgeist. We begin to think it, with it and through it, even as its technical operations begin to take place in the world. And in thinking through it, indeed, nanotechnology "disassembles"; it "deconstructs you on a molecular level" (figure 4). Nanovision—this term for thinking through nanotechnology in its theoretical operations and material instantiations—carries out a techno-deconstruction, an unraveling, a desedimentation of human being. For nanovision animates the molecular tensions within humanism and the human body itself and works through these molar structures toward molecular modalities of becoming.

Nanovision's techno-deconstructive effects problematize the difference between the human and the extrahuman, opening the human to those nanotechnologies that "are in the air," be they machinic "nanites" per se or operational forms of technical nano-knowledge. Nanovision finds the point, the fissure, where presentist humanism fails, and it is at this critical failure that the possibility of posthumanism emerges, as a processual movement of self-othering.[45] This blind spot or limit within the scope of humanism is the very condition for becoming other than human: it is the fault line marking the trace of the inhuman within the human, of the future within the present, of the impossible within the possible—a critical failure of what is properly thinkable within human thought. Seeing what cannot be seen, discovering monumental historical changes that are both inevitable and un-

4. Ben Templesmith, *Singularity 7* (2005). In the scene of nanotechnological disintegration, human beings are graphically broken down and analyzed, "deconstruct[ed] . . . on a molecular level." © 2005 Ben Templesmith and Idea + Design Works, LLC.

known, nanovision makes the outside appear within the inside as a trace of absolute alterity. It sees, exposes, and produces the invisible future on this side of the Singularity—the future is presented, emerging from nanotechnological developments that have not yet happened (and perhaps never will) but, in being anticipated, enact change in the world. In bringing to light the traces of this unimaginable future inside the human present, nanovision thus finds the tunnel, the exit, the way out, releasing a flooding technological surge through the constricting sphincter of the Singularity—which is, therefore, already happening.

In this book, I will examine the various ways nanovision manifests, informs, and transforms the emerging culture of nanotechnology. We will

quickly begin to see through the techno-deconstructive dynamic between blindness and insight, humanism and posthumanism, science and science fiction, that operates as the condition of possibility for engineering the future. In other words, we will begin to see through the singularity of nano-vision . . .

. . . and therein discover that the future is fully capable of accommodating not just one, but many, nanovisions.

1

NANOTECHNOLOGY IN THE AGE OF POSTHUMAN ENGINEERING: *Science as Science Fiction*

> Now nanotechnology had made nearly anything possible, and so the cultural role in deciding what *should* be done with it had become far more important than imagining what *could* be done with it.
> —Neal Stephenson, *The Diamond Age*

> Long live the new flesh.
> —*Videodrome*

K. Eric Drexler, pioneer and popularizer of the emerging science of nanotechnology, has summarized the ultimate goal of this field as "thorough and inexpensive control of the structure of matter."[1] Nanotechnology entails the practical manipulation of atoms; it is engineering conducted on the molecular scale. Many scientists involved in this ambitious program envision building nanoscopic machines, often called "assemblers" or "nanobots," that would be used to construct objects on an atom-by-atom basis. Modeled largely on biological "machines" like enzymes, ribosomes, and mitochondria—even the cell—these nanomachines would have specific purposes, such as binding two chemical elements together or taking certain compounds apart, and would also be designed to replicate themselves so that the speed and scale of molecular manufacturing may be increased. Several different types of nanomachines would act together to build complex objects precise and reproducible down to every atomic variable. Other researchers imagine using self-assembling macromolecular systems for