Ahead of Time:
Gerald Feinberg and the Governance of Futurity

by Colin Milburn*

ABSTRACT

Looking back at his research on tachyons in the 1960s and 1970s, the physicist Gerald Feinberg recalled that he started thinking about particles that go faster than light after reading James Blish's 1954 science fiction story "Beep." While the technical conceits of Blish's tale may have stirred Feinberg's curiosity, its literary implications were yet more significant. As a story about faster-than-light messages that travel backward in time, "Beep" thematizes the capacity of speculative fictions to affect the present and reorient the future. For Feinberg, stories like "Beep" and Arthur C. Clarke's 1953 novel *Childhood's End* offered conceptual resources as well as models for practice, affirming a science fiction way of doing science. By attending to Feinberg's work on tachyons as well as his ventures in futurology, such as *The Prometheus Project*, this essay shows how Feinberg's reading of science fiction reinforced a speculative approach to knowledge and innovation, an understanding of theoretical science as intimately aligned with science fiction, and a conviction that science fiction was a vital instrument for science policy and social change.

In 1967, the physicist Gerald Feinberg published a quantum field analysis of a purely hypothetical class of faster-than-light particles that he dubbed "tachyons." This was a rather unorthodox research project, to say the least. While the possibility of objects moving at superluminal velocities had been considered since the late nineteenth century, the impact of Einstein's 1905 special theory of relativity seemed to put further study of faster-than-light speed into the realm of pure science fiction. According to special relativity, it would require infinite energy to accelerate an object with real mass up to the speed of light. In other words, as Einstein put it, "superluminary velocities have no possibility of existence."[1] Even were it possible to transmit signals faster than light, such transmissions could appear to some observers as having trav-

* Department of English, 273 Voorhies Hall, One Shields Ave., University of California, Davis, CA 95616, USA; cnmilburn@ucdavis.edu.

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[1] Albert Einstein, "On the Electrodynamics of Moving Bodies," in *The Collected Papers of Albert Einstein, Volume 2: The Swiss Years: Writings, 1900–1909*, ed. John Stachel, David C. Cassidy, Jürgen Renn, and Robert Schulmann, English translation supplement, trans. Anna Beck (Princeton, N.J., 1989), 140–71, on 170.

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eled backward in time, introducing the uncanny possibility of information from the future influencing past events. Not only would this violate the principles of physical causality, it could also lead to certain paradoxes, for example, if messages were to arrive before they were sent and preempt the sender from sending them. Special relativity therefore seemed to squash any fantasies of faster-than-light travel and backward communications from the future—at least in the zones of serious science.[2]

But in 1962, the physicists Oleksa-Myron Bilaniuk, V. K. Deshpande, and George Sudarshen postulated the existence of subatomic particles that always travel at superluminal velocities. Such "meta" particles would never confront the speed of light as an upper barrier because they would be already beyond it. Moreover, the problem of temporal paradoxes could be solved by relativistic reinterpretation, insofar as observers in some frames of reference would perceive such a particle "not as a weird negative energy particle traveling backward in time, but as a positive energy particle traveling forward in time, but going in the opposite direction."[3] Likewise, any apparent violations of causality could be reinterpreted as causal events, as a matter of perspective.

Feinberg, who had joined the faculty at Columbia University in 1959, was fascinated by this possibility. From the late 1940s onward, the field of high energy physics had witnessed the number of elementary particles grow by leaps and bounds—an explosion of the so-called particle zoo. Thanks to cosmic ray research and, especially, the development of increasingly powerful accelerators and detectors, more than one hundred subatomic species had been discovered by the mid-1960s.[4] Feinberg himself was already a contributor to the particle zoo, having predicted the muon neutrino in 1958. (Its existence was demonstrated in 1962 by his colleagues Leon Lederman, Melvin Schwartz, and Jack Steinberger, who later shared the Nobel Prize for their work.) He was confident that even more exotic beasts would yet emerge from the depths of the subatomic universe. But he also foresaw that, more than simply adding another strange critter to an expanding menagerie, adventurous research on bits of matter that go faster than light could potentially upend modern physics—whether these things existed or not.

So, encouraged by his previous success with the muon neutrino, Feinberg took up the question of faster-than-light particles with a bold territorial move: he named them. Rendering them as objects of relativistic quantum field theory, figuring them as excitations of a quantum field with imaginary mass, Feinberg also conjured them as objects of discourse: "One description is presented . . . for noninteracting faster than light particles, which we call *tachyons*."[5] Shortly afterward, in a *Scientific American*

[2] On the history of faster-than-light communication theories and time-travel scenarios, see Paul J. Nahin, *Time Machines: Time Travel in Physics, Metaphysics, and Science Fiction*, 2nd ed. (New York, N.Y., 1999).

[3] O. M. P. Bilaniuk, V. K. Deshpande, and E. C. G. Sudarshan, "'Meta' Relativity," *Amer. J. Phys.* 30 (1962): 718–23, on 719. For reflections on this foundational work, see Oleksa-Myron Bilaniuk, "Tachyons," *Journal of Physics: Conference Series* 196 (2009): 012021.

[4] On the history and practices of particle physics, see Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago, Ill., 1997); David Kaiser, *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics* (Chicago, Ill., 2005); Andrew Pickering, *Constructing Quarks: A Sociological History of Particle Physics* (Chicago, Ill., 1984); and Sharon Traweek, *Beamtimes and Lifetimes: The World of High Energy Physicists* (Cambridge, Mass., 1988).

[5] Gerald Feinberg, "Possibility of Faster-Than-Light Particles," *Physical Review* 159 (1967): 1089–1105, on 1090.

article introducing tachyons to a wider audience, Feinberg highlighted the strategic nature of this maneuver: "In anticipation of the possible discovery of faster-than-light particles, I named them tachyons, from the Greek word *tachys*, meaning swift."[6] Feinberg's philological and theoretical production of these speculative objects ahead of time, I venture, represents a science fiction way of doing science, a way of staking claims on the future.

After all, Feinberg was known as much for his intense love of science fiction as for his prodigious talent as a physicist. When he passed away in 1992, the obituaries described him as a "devoted scientist and avid science-fiction fan."[7] And sure enough, his work on tachyons was to some degree indebted to his reading of science fiction. As the physicist and science fiction writer Gregory Benford recalled, "He told me years later that he had begun thinking about tachyons because he was inspired by James Blish's short story 'Beep.' In it, a faster-than-light communicator plays a crucial role in a future society . . . The communicator necessarily allows sending of signals backward in time . . . Feinberg had set out to see if such a gadget was theoretically possible."[8]

While Blish's 1954 story no doubt piqued Feinberg's curiosity, I want to suggest that its value for Feinberg's own work was less in its technical provocations than its literary ones. For "Beep" affords an understanding of theoretical science as equivalent to science fiction: not a purveyor of mere flights of fancy, but a generator of *consequential fictions* with the capacity to inform the circumstances of their own actualization. In other words, they are fictions that contribute to the conditions of possibility, the enabling contexts for discovery and innovation. From Feinberg's perspective, his reading of "Beep" reinforced a forward-looking, conjectural approach to the production of scientific knowledge. It confirmed his sense of the motivating power of fictive narratives, the robust forms of deliberation and anticipation made available by engaging in pretense. Moreover, it indicated that science fiction could become a model for science policy, shaping the trajectory of high-tech society. For Feinberg, then, it validated a lifetime of thinking about imaginary futures, because it suggested how science fiction could change the world.

READING THE FUTURE

Blish's text unfolds as a story within a story. The framing narrative focuses on the governmental organization known as the Service, which is responsible for overseeing the smooth advancement of galactic civilization. This massive interplanetary operation depends on the technology of the Dirac communicator. Any message sent through one Dirac communicator is received instantaneously by all others, preceded by a small

[6] Gerald Feinberg, "Particles That Go Faster Than Light," *Sci. Amer.* 223 (February 1970): 69–77, on 70.

[7] Leyla Kokmen, "Prof. Dies after Fight with Cancer," *Columbia Spectator*, 23 April 1992, 1.

[8] Gregory Benford, "Old Legends," in *New Legends*, ed. Greg Bear and Martin H. Greenberg (New York, N.Y., 1995), 270–84, on 276. See also Benford, "Time and *Timescape*," *Sci. Fict. Stud.* 20 (1993): 184–90. Linking his interests in superluminal matters to Blish's 1954 story, Feinberg implied that his research antedated Bilaniuk, Deshpande, and Sudarshan, "'Meta' Relativity" (cit. n. 3); as well as Sho Tanaka, "Theory of Matter with Super Light Velocity," *Progress of Theoretical Physics* 24 (1960): 171–200. Feinberg's 1967 *Physical Review* paper, "Possibility" (cit. n. 5), cites these earlier publications in its first footnote, along with another predecessor: "G. Feinberg (unpublished)."

beep of sound. In the nested story, which concerns the origins of the communicator, the video commentator Dana Lje discovers that the "beep is the simultaneous reception of *every one of the Dirac messages which have ever been sent, or ever will be sent*."[9]

The narrative symbolically aligns Lje's discovery with lies and illusions—the fictive as such. Her disclosure of the beep's meaning depends on an elaborate charade where she poses as a man named J. Shelby Stevens. On the other hand, Robin Weinbaum, the director of the Service, is fully aligned with the regime of truth. He represents a government that does not tolerate fiction: "Just in case you're not aware of the fact, there are certain laws relating to giving false information to a security officer . . . plus various local laws against transvestism, pseudonymity and so on" (30). Weinbaum demands transparency. He likewise insists on stripping any obscuring "noise" from otherwise pure signals. He instructs his assistant to excise the beep: "Margaret, next time you send any Dirac tapes in here, cut that damnable *beep* off them first" (23). Weinbaum, agent of truth and law, disregards this literally preposterous noise. Its meaning only comes to light through Lje's fictive performance.

Lje's process of extracting discrete transmissions from the beep is an interpretive practice described as reading: "I can read the future in detail" (31). It apprehends the faster-than-light messages as *texts*, many of which are strange, mystifying, and unnerving: "Once you know, however, that when you use the Dirac you're dealing with time, you can coax some very strange things out of the instrument" (39). Yet these "strange things" are recognized as consistent with reality, explicable by scientific logic. Which is to say, they have the qualities of science fiction:

> She paused and smiled. "I have heard," she said conversationally, "the voice of the President of our Galaxy, in 3480, announcing the federation of the Milky Way and the Magellanic Clouds. I've heard the commander of a world-line cruiser, traveling from 8873 to 8704 along the world line of the planet Hathshepa, which circles a star on the rim of NGC 4725, calling for help across eleven million light-years—but what kind of help he was calling for, or will be calling for, is beyond my comprehension. And many other things. When you check on me, you'll hear these things too—and you'll wonder what many of them mean." (39)

These vignettes draw from a common repertoire of science fiction tropes—enormous space ships, intergalactic civilizations, time travel—and they bring forth a sense of wonder and wonderment: "Weinbaum, already feeling a little dizzy . . . wanted only scenes and voices, more and more scenes and voices from the future. They were better than aquavit" (42). Alluring and bewildering, they evade full rational comprehension even while indicating that such comprehension is possible—some day: "You'll know the future, but not what most of it means. The farther into the future you travel with the machine, the more incomprehensible the messages become, and so you're reduced to telling yourself that time will, after all, have to pass by at its own pace, before enough of the surrounding events can emerge to make those remote messages clear" (39).

[9] James Blish, "Beep," *Galaxy Science Fiction*, February 1954, 6–54, on 36. Further page citations appear parenthetically in the text (emphasis in the original).

The effect of these weird messages from the future is instead a new perception of the present, namely, as the historical context for incredible changes to come.[10] Viewing a beep transmission of a "green-skinned face of something that looked like an animated traffic signal with a helmet on it," Weinbaum exclaims, "And we'll be using non-humanoids there! What was that creature, anyhow?" (42). Weinbaum sees the alien as his own future, albeit radically estranged. This surprising future puts the present in new light, exposing its humanist biases ("looked like an animated traffic signal"), even while suggesting the possibility for things to be otherwise.

The beep is therefore a figure for science fiction as such. While Lje's "method of, as she calls it, reading the future" (35) understands the beep messages to represent inevitable events—evidence for a perfectly acausal universe—she nevertheless interprets them as self-fulfilling prophesies: "Since I was going to be married to you [Weinbaum] and couldn't get out of it, I set out to convince myself that I loved you. Now I do. . . . But I had no such motives at the beginning. Actually, there are never motives behind actions. All actions are fixed. What we called motives evidently are rationalizations by the helpless observing consciousness, which is intelligent enough to smell an event coming—and, since it cannot avert the event, instead cooks up reasons for wanting it to happen" (32–33). Taking the beep messages seriously, Lje "cooks up reasons" to ensure the events will take place. She invents fictions of causality ("rationalizations") that become indistinguishable from actual causes.

It is a method of reading the future that the Service then implements as *policy*. In the framing narrative, hundreds of years later, Serviceman Krasna says,

> Our interests as a government depend upon the future. We operate *as if* the future is as real as the past, and so far we haven't been disappointed: the Service is 100% successful. But that very success isn't without its warnings. What would happen if we *stopped* supervising events? We don't know, and we don't dare take the chance. Despite the evidence that the future is fixed, we have to take on the role of the caretaker of inevitability. We believe that nothing can possibly go wrong . . . but we have to act on the philosophy that history helps only those who help themselves. . . . Our obligation as Event Police is to make the events of the future possible, because those events are crucial to our society—even the smallest of them. (43, emphasis in the original)

This "as if" approach does not draw a hard line between fact and theory, truth and lies, or science and science fiction.[11] The Service accepts the beep messages as if they were reliable prophesies, but treats them in practice as speculative forecasts that might fail without a vast technoscientific infrastructure designed to "make the events of the future possible." In its role as "Event Police," the Service assembles numerous technical resources: "We have some foreknowledge, of course. . . . But we have ob-

[10] Fredric Jameson argues that science fiction's "mock futures serve the quite different function of transforming our own present into the determinate past of something yet to come. . . . SF thus enacts and enables a structurally unique 'method' for apprehending the present as history"; see Fredric Jameson, *Archaeologies of the Future: The Desire Called Utopia and Other Science Fictions* (New York, N.Y., 2005), 288. This function is one aspect of cognitive estrangement, described by Darko Suvin, *Metamorphoses of Science Fiction: On the Poetics and History of a Literary Genre* (New Haven, Conn., 1979).

[11] Michael Saler, *As If: Modern Enchantment and the Literary Prehistory of Virtual Reality* (Oxford, UK, 2012). See also Hans Vaihinger, *The Philosophy of "As If": A System of the Theoretical, Practical and Religious Fictions of Mankind*, trans. C. K. Ogden (New York, N.Y., 1925).

vious other advantages: genetics, for instance, and operations research, the theory of games, the Dirac transmitter—it's quite an arsenal, and of course there's a good deal of prediction involved in all those things" (11). Even with knowledge of things to come, the Service marshals the tools of various scientific disciplines to turn speculations and "as if" scenarios into lived events.

All of this represents an explicitly *constructivist* approach to truth, a model for the generation of scientific knowledge that does not excise science fiction (as Weinbaum once excised the beep), but rather upholds its crucial role for the advancement of science and society.

VERGING ON FICTION

To the degree that "Beep" represents a science fiction way of governing the future, its appeal to a "devoted scientist and avid science-fiction fan" like Feinberg seems obvious, in retrospect. The Service's decision to reinterpret causally uncertain events in a causal way, sidestepping potential paradoxes, is tantalizingly similar to the principle of reinterpretation developed in Feinberg's own work. According to Feinberg, actual instrumentation for detecting the absorption of tachyons from the future would make distinctions between emission and absorption, sending and receiving, undecidable. Inclined to causal explanations, an observer would therefore "naturally describe" the tachyon detector as if it were spontaneously sending signals forward rather than receiving them from the future.[12]

For the same reason, Feinberg suggested that a device such as the Dirac communicator, if taken literally, would not be possible.[13] The relevance of "Beep" for thinking about tachyons, however, is more figural. For the story presents a model of scientific practice and technological governance that treats physical theories and interpretations of data as fictions, but not "mere" fictions; rather, the Dirac messages become the conditions for further experimentation, triggering additional research and decisive actions. They are science fictions that enable their own materialization in the form of consequential practices.

Feinberg offered a similar perspective in his writings on tachyons: "Having convinced ourselves that the existence of faster-than-light particles does not imply any contradiction of relativity, we must nevertheless leave the determination of whether such objects really happen in nature to the experimental physicist."[14] Feinberg here presents tachyons as consequential fictions that galvanize experiments—no more,

[12] Feinberg writes, "Therefore, while it does appear possible to construct kinematic closed cycles using tachyons in which signals are sent back to the past, a careful examine of the methods of detection, with due regard to the interpretation of absorption of negative-energy tachyons as emission of positive-energy tachyons, leads to the conclusion that such closed cycles will not be interpreted as reciprocal signaling, but rather as uncorrelated spontaneous emission"; Feinberg, "Possibility" (cit. n. 5), 1103. Though such reinterpretation was already suggested by Bilaniuk, Deshpande, and Sudarshen, it is now often called the "Feinberg reinterpretation principle." Notably, it echoes the solution proposed by Ernst Stueckelberg and Richard Feynman to account for the negative energy of antimatter particles in quantum field theory; see R. P. Feynman, "The Theory of Positrons," *Physical Review* 76 (1949): 749–59.

[13] Feinberg writes, "A conclusion warranted by this argument is that tachyons cannot be used to send reliable signals, either forward or backward in time, in the sense that one cannot completely control the outcome of an experiment to produce or absorb them"; see Feinberg, "Possibility" (cit. n. 5), 1092.

[14] Feinberg, "Particles" (cit. n. 6), 72.

no less. Certainly, they have provoked numerous studies and experiments over the last half century. Even failure to prove their existence has led to new theoretical interpretations. For example, we could point to the "tachyonic field" concept in quantum field theory, taken to mathematically indicate field instabilities rather than real particles. The appearance of tachyons—and efforts to resolve them—have likewise been critical in the history and development of string theory.[15] We could also point to the abiding hope for faster-than-light signals—a hope projected always into the future—as suggested by recent research on quantum tunneling, or more tellingly, by the premature 2011 declaration by scientists at CERN, the European Organization for Nuclear Research in Geneva, Switzerland, that they had discovered neutrinos traveling faster than light (a claim later disproved).[16]

Yet even in generating such experimental adventures, tachyons have not ceased to be understood as science-fictional objects. Already in 1970, Feinberg conceded that experimental results seemed to suggest that tachyons are not actually real, but to him this only further demonstrated the value of such entities. After all, it may be likely that "tachyons simply do not exist . . . [but] we may not understand why it should be so until we reach a much deeper understanding of the nature of elementary particles than now exists."[17] Which is to say, as nothing other than science fictions, they indicate the degree to which extant physical theories are themselves provisional, constructed, and prone to change in the future.

In this regard, Feinberg aligned with other physicists who emphasized the science-generating capacities of theoretical entities that, even if they might not actually exist, could nevertheless defamiliarize inherited models and presage an altered way of seeing. Compare, for example, Murray Gell-Mann's proposition in 1964 that hadrons are not elementary particles but are instead built up from combinations of things he called "quarks." For Gell-Mann, the ontological status of quarks was indeterminate, but fair game for speculation. As his first paper on quarks famously concludes, "It is fun to speculate about the way quarks would behave if they were physical particles of finite mass (instead of purely mathematical entities as they would be in the limit of infinite mass)."[18] Like Feinberg's writing on tachyons, Gell-Mann's quark paper underscores the "as if," the subjunctive mood ("if they were physical particles"). It extrapolates the implications of these prospective entities into a speculative chronology, a "what if?" narrative that looks backward as well as forward. It imagines a previously undisclosed

[15] Dean Rickles, *A Brief History of String Theory: From Dual Models to M-Theory* (Heidelberg, Ger., 2014).

[16] Günter Nimtz, "Tunneling Confronts Special Relativity," *Found. Phys.* 41 (2011): 1193–9; E. Kapuścik and R. Orlicki, "Did Günter Nimtz Discover Tachyons?" *Ann. Physik* 523 (2011): 235–8; T. Adam et al. (OPERA collaboration), "Measurement of the Neutrino Velocity with the OPERA Detector in the CNGS Beam," preprint, submitted 17 November 2011, *arXiv:1109.4897v1*. For an account of what happened in the OPERA experiment, see Ransom Stephens, "The Data That Threatened to Break Physics," *Nautilus* 24 (2015), http://nautil.us/issue/24/Error/the-data-that-threatened-to-break-physics.

[17] Feinberg, "Particles" (cit. n. 6), 77. Bilaniuk and Sudarshan had made the same point: "We find the question of existence of the hypothetical superluminal particles to be a challenging new frontier. Regardless of the outcome of the search for tachyons, investigations in this field must invariably lead to a deeper understanding of physics. If tachyons exist, they ought to be found. If they do not exist, we ought to be able to say why not"; see Olexa-Myron Bilaniuk and E. C. George Sudarshan, "Particles Beyond the Light Barrier," *Phys. Today* 22 (1969): 43–51, on 51.

[18] M. Gell-Mann, "A Schematic Model of Baryons and Mesons," *Physics Letters* 8 (1964): 214–5, on 215.

past: "Ordinary matter near the earth's surface would be contaminated by stable quarks as a result of high energy cosmic ray events throughout the earth's history, but the contamination is estimated to be so small that it would never have been detected." It then dashes ahead, venturing upon experimental trials to come: "A search for stable quarks . . . at the highest energy accelerators would help to reassure us of the nonexistence of real quarks." The conditional futurity ("would help to reassure us") allows Gell-Mann to hedge his bets, demurring on the reality of "real quarks" while remaining open to whatever might serendipitously emerge from cosmic rays or particle accelerators; the provisory formulations invite further research. As late as 1969, Gell-Mann observed, "The quark is just a notion so far. . . . It is a useful notion, but actual quarks may not exist at all."[19]

Yet even if they were to prove "only fictitious," Gell-Mann indicated it would still be feasible to speak of them in "as if" terms, for example, in the case where "hadrons act *as if* they were made up of quarks but no quarks exist."[20] Quarks were objects of theoretical conjecture, signifiers of possibility. Of course, quarks would eventually become real—affirmed retroactively by experimental data, even as the theoretical framing continued to be debated and refined.[21] The same can be said for many other wild hypotheses, prototypes, forward-looking statements, and promissory visions in the history of science and technology. As tools of the imagination, fictions to think with, they solicit experiments and other technical responses, stirring further speculations in their wake. They instantiate a way of doing science that often verges on the domain of science fiction, concerned with the articulation of cognitively estranging concepts and extrapolating the conditions under which things that seem bizarre or impossible in the present could be taken for granted in the future. It is an approach that embraces the "as if" and the exercise of pretense, serious and playful at the same time. According to Gell-Mann, who had been a reader of science fiction since his youth, it even provides a similar recreational pleasure. As he noted, "it is fun to speculate."[22]

To be sure, the discourse of science fiction regularly affirms the pleasures and playfulness of scientific speculation. In February 1967, five months before the publication of Feinberg's first tachyon paper, the science fiction writer and biochemistry professor Isaac Asimov devoted his regular science column in *The Magazine of Fantasy and Science Fiction* to the question of superluminal velocities. Irritated by an episode of the television show *It's About Time*, a 1966–1967 sitcom about time-traveling as-

[19] Gell-Mann quoted in "Gell-Mann of Caltech Awarded Nobel Prize," *Los Angeles Times*, 31 October 1969, 29.

[20] Murray Gell-Mann, "Quarks," *Acta Physica Austriaca, Suppl.* 9 (1972): 733–61, on 746 (emphasis mine).

[21] On the shifting reality of quarks, see Pickering, *Constructing Quarks* (cit. n. 4); and George Johnson, *Strange Beauty: Murray Gell-Mann and the Revolution in Twentieth-Century Physics* (New York, N.Y., 1999). In 1964, the physicist George Zweig independently developed an equivalent theory of hadrons as made of more fundamental particles ("aces"), but he held a stronger view about the concrete reality of such particles than Gell-Mann initially did; see G. Zweig, "Memories of Murray and the Quark Model," *International Journal of Modern Physics A* 25 (2010): 3863–77.

[22] Gell-Mann has often indicated his interest in science fiction and its concepts; see Murray Gell-Mann, "Opening Remarks to the Session on New Concepts," *Nuclear Instruments and Methods in Physics Research* A271 (1988): 165–6; and Gell-Mann, *The Quark and the Jaguar: Adventures in the Simple and the Complex* (New York, N.Y., 1994), 19, 21, 113, 165, 370. On speculative play and scientific make-believe, see Colin Milburn, *Mondo Nano: Fun and Games in the World of Digital Matter* (Durham, N.C., 2015). On fictionalism in science more generally, see Mauricio Suárez, ed., *Fictions in Science: Philosophical Essays on Modeling and Idealization* (New York, N.Y., 2009).

tronauts, Asimov diligently explained why anything moving faster than light was preposterous, forbidden by special relativity: "Impossible, That's All!"[23] A year later, the science fiction writer and futurist Arthur C. Clarke published a good-humored rejoinder in the same magazine titled "Possible, That's All!" Clarke poked fun at Asimov for being out of touch with current research:

> I am indebted, if that is the word, to Dr. Gerald Feinberg of Columbia University for this idea. His paper "On the Possibility of Superphotic Speed Particles" (privately printed; posted in plain, sealed envelopes) points out that since sudden jumps from one state to another are characteristic of quantum systems, it might be possible to hop over the "light barrier" without going through it. . . . Even if there is no way through the light-barrier, Dr. Feinberg suggests that there may be another universe on the other side of it, composed entirely of particles that cannot travel slower than the speed of light.[24]

An early recipient of Feinberg's manuscript, Clarke located himself on the cutting edge, ahead of the curve, while suggesting that Asimov had slipped behind. Clarke even jested about temporal reversal, pretending to be much younger than Asimov now, despite actually being three years older: "The galactic novels of my esteemed friend Dr. Asimov gave me such pleasure in boyhood that it is with great reluctance that I rise up to challenge some of his recent statements."[25] Caught off guard, Asimov wrote two responses, conceding the theoretical interest of tachyons but doubling down on the Einsteinian light barrier, the "luxon wall," as a fundamental limit separating our real-mass universe from an imaginary-mass universe.[26] He also addressed the history of thinking about superluminal particles: "This was done for the first time with strict adherence to relativistic principles (as opposed to mere science-fictional speculation) by Bilaniuk, Deshpande, and Sudarshan, in 1962, and such work hit the headlines at last when Gerald Feinberg published a similar discussion in 1967."[27] Asimov allowed that, while tachyons were probably imaginary in more than one sense, their abidance by the rules of modern physics would distinguish them from earlier examples of "mere science-fictional speculation." His comment nevertheless suggested how much theoretical science actually needs science fiction, if only for the sake of contrast. Certainly, in February 1969, *Time* magazine featured the dispute between Asimov and Clarke as a framing anecdote for its profile of Feinberg: "For Columbia University Physicist Gerald Feinberg, the monthly magazine *Fantasy and Science Fiction* is as compelling as any learned scientific journal. It has printed a continuing debate between authors Isaac Asimov and Arthur C. Clarke over the existence of a particle that travels faster than light. . . . Feinberg's fascination is understandable. The particle is his conception, although he is still not certain that it really exists."[28]

[23] Isaac Asimov, "Impossible, That's All!" *Magazine of Fantasy and Science Fiction*, February 1967, 113–23.

[24] Arthur C. Clarke, "Possible, That's All!" *Magazine of Fantasy and Science Fiction*, October 1968, 63–8, on 64.

[25] Ibid., 63.

[26] Isaac Asimov, response to Clarke, "Possible, That's All!" *Magazine of Fantasy and Science Fiction*, October 1968, 68–9; Isaac Asimov, "The Luxon Wall," *Magazine of Fantasy and Science Fiction*, December 1969, 96–105.

[27] Asimov, "Luxon Wall" (cit. n. 26), 103.

[28] "Exceeding the Speed Limit," *Time*, 14 February 1969, 50. On the prominence of Asimov, Clarke, and other fiction writers in futurological discourse, see Peter J. Bowler, *A History of the Future: Prophets of Progress from H. G. Wells to Isaac Asimov* (Cambridge, UK, 2017).

Situated against a background of science fiction, the work of theoretical physics seemed a more intense form of the same kind of fabulation, a more technical game of make-believe.

Meanwhile, tachyons triggered extended discussions among physicists—and the research publications often invoked fictive narratives and motifs. For example, the physicist Lawrence Schulman argued that the time-travel stories of Robert A. Heinlein, Michael Moorcock, Brian Aldiss, and Robert Silverberg were helpful resources for theorizing about tachyonic physics and reverse causality: "It will be seen that the results of this discussion will be in general accord with a consensus of science fiction writers who have dealt with this theme."[29] The physicist Frank Jones noted that Schulman's analysis exemplified the tendency of tachyons to elicit a certain genre of images: "The sort of images that are conjured up by this possibility is illustrated by the fact that in one recent discussion in the literature almost half of the references cited were to science fiction stories."[30]

Tachyons also proliferated in science fiction itself, entering the repertoire of standard genre tropes. Remarkably, the first novel to include tachyons as a plot device was written by James Blish. Since 1967, Blish had been adapting the *Star Trek* television series into books of short stories—a contract job that secured his financial livelihood in those years, because the *Star Trek* volumes outsold his other books by a fair margin.[31] As part of this arrangement, in 1970, he published *Spock Must Die!*, a full-length *Star Trek* novel. While it featured characters from the television series, *Spock Must Die!* was Blish's creation: an allegory about the dilemmas of originality that, like "Beep," depicts a future built from other speculative fictions. In the novel, the chief engineer of the starship *Enterprise*, Scotty, decides to redesign the ship's transporter system to utilize tachyons: "Tachyons *canna* travel any *slower* than light, and what their top speed might be has nae been determined."[32] Instead of physically beaming crew members to distant locations, the new transporter sends tachyon copies, zipping them through Hilbert space, while the original people remain safely aboard the *Enterprise*. During the first test, however, something goes wrong; the transporter creates a physical duplicate of Mr. Spock.

The two Spocks appear identical. Yet one Spock is actually the mirror image of the other, with reversed chirality all the way down to his elementary particles. Scotty discerns that the transporter's tachyon beam hit a "deflector screen" around the planet Organia, which inverted the signal. Whereas the original Spock is loyal to the *Enterprise*, the duplicate Spock is secretly an enemy, working to sabotage the mission.

Eventually, the two Spocks face off in a psychic battle behind the tachyon-deflecting screen of Organia, each trying to destroy the other through the force of imagination alone: a "combat of dreams" (89). During this climactic duel, Captain Kirk is caught

[29] L. S. Schulman, "Tachyon Paradoxes," *Amer. J. Phys.* 39 (1971): 481–4, on 481. The first peer-reviewed response to Feinberg was Roger G. Newton, "Causality Effects of Particles That Travel Faster Than Light," *Physical Review* 162 (1967): 1274. Newton argued that tachyons need not be fatally paradoxical; if we run an "experiment in which an effect would precede its cause," we simply need to acknowledge a weird universe that "would, in principle, make precognition experiments possible."

[30] Frank C. Jones, "Lorentz-Invariant Formulation of Cherenkov Radiation by Tachyons," *Physical Review D: Particles and Fields* 6 (1972): 2727–35, on 2727.

[31] David Ketterer, *Imprisoned in a Tesseract: The Life and Work of James Blish* (Kent, Ohio, 1987), 249–50, 358.

[32] James Blish, *Spock Must Die!* (New York, N.Y., 1970), 13. Further page citations appear parenthetically in the text.

in a torrent of dream stuff, a flood choked with creatures from science fiction and fantasy lore. He sees "the bedraggled bodies of a wide variety of small animals from a dozen planets—rabbits, chickens, skopolamanders, tribbles, unipeds, gormenghastlies, ores, tnucipen, beademungen, escallopolyps, wogs, reepicheeps, a veritable zoo of drowned corpses, including a gradually increasing number of things so obscene that even Kirk, for all his experience in exoteratology, could not bear to look at them" (92). It is a cascade of allusions. The tribbles from *Star Trek* mix with unipeds from Stanley G. Weinbaum's "Parasite Planet" (1935); the gormenghastlies nod to Mervyn Peake's *Gormenghast* series (1946–1949); the tnucipen reference the tnuctipun of Larry Niven's *World of Ptavvs* (1966); the reepicheeps point to C. S. Lewis's *Chronicles of Narnia* (1950–1956); the wogs, laden with racist associations, refer to the lexicon of L. Ron Hubbard's Scientology (as a term for non-Scientologists); and so forth. Blish even cites his own fictions here; the skopolamanders evoke "A Hero's Life" (1966), and the beademungen come from "Common Time" (1953). As Kirk watches these imaginary casualties float by, it becomes clear that the battle between the Spocks is a conflict over speculative fiction, or the literary imagination as such.

The replicate Spock asserts his superiority by drawing an overt literary metaphor: "My existence . . . is a fortuitous revision, and a necessary one, of a highly imperfect first draft. It is the scribbled notes which should be eliminated here, not the perfected work. . . . Perhaps, crude recension though you are, you could be brought to understand that" (91). Playing along, the original Spock responds, "The true scholar . . . prizes all drafts, early and late. But your literary metaphor is far from clear, let alone convincing" (91). While the duplicate Spock derides his predecessor's "smudgy incunabular existence" (91), the original Spock summons an imaginary tornado, which thrusts the replicate into the same tachyon screen that created him in the first place. The fiction is so persuasive that the replicate literally dies: "It was a combat of illusions—and in the end, the replicate *believed* he had been driven into the screen. That was sufficient" (95). Thus ends the adventure of a "fortuitous revision," bounced from screen to text and back again.

Transparently, *Spock Must Die!* is a metaphor for its own composition, coming to terms with its relation to preexisting fictions. As Blish writes in his authorial preface, "Unlike the preceding three STAR TREK books, this one is not a set of adaptations of scripts which have already been shown on television, but an original novel built around the characters and background of the TV series conceived by Gene Roddenberry" (ix). He conjectures that whereas he had been translating the TV show into prose, *Spock Must Die!* might reverse the process: "And who knows—it might make a television episode, or several, some day" (ix). Although the novel establishes that adaptations may not have the best interests of the original at heart, it nevertheless indicates that a derivative work may make a separate claim to authenticity. As one Spock notes, "I can assure you that I *know* that I am the original—but this knowledge is not false even if I am in fact the replicate" (378). Indisputably, adaptations take on a life of their own.

By the same token, *Spock Must Die!* is also about the relationship between science and science fiction. Tellingly, the story begins with Scotty's effort to harness the untapped power of tachyons, to boldly go where no one has gone before ("particles that travel faster than light—for which nobody's ever found any use" [13].) The book highlights the poaching of scientific concepts for purposes of fiction. But the tachyons only create a simulacrum, Spock's sinister twin: a high-tech derivative of a sci-

ence fiction icon. The tachyonic reproduction of Spock points to the novel's more extensive thematization of fiction as an adaptive resource for technical innovation. For example, to outwit the Klingon forces threatening the *Enterprise*, Uhura proposes to transmit a message to Starfleet Command in Eurish:

> It's the synthetic language James Joyce invented for his last novel, over two hundred years ago. It contains forty or fifty other languages, including slang . . . You know the elementary particle called the quark; well, that's a Eurish word. Joyce himself predicted nuclear fission in the novel I mentioned. I can't quote it precisely, but roughly it goes, "The abnihilisation of the etym expolodotonates through Parsuralia with an ivanmorinthorrorumble fragoromboassity amidwhiches general uttermost confussion are perceivable moletons scaping with mulicules." There's more, but I can't recall it—it has been a long time since I last read the book. (49)

Uhura draws attention to the polysemic, heteroglossic nature of literary discourse—hyperbolized in Joyce's invented Eurish that "contains forty or fifty other languages" in itself—as well as the interplay of science and fiction foregrounded by Joyce's last novel. As Uhura recalls, *Finnegan's Wake* is rife with references to modern physics; she even attributes the "prediction" of nuclear fission to Joyce, retroactively. Moreover, Uhura remembers that *Finnegan's Wake*—in particular, the line "Three quarks for Muster Mark!"—was a semiotic resource for Murray Gell-Mann. Certainly, Gell-Mann footnoted Joyce's book in his 1964 quark paper, and while he later claimed that he took only Joyce's spelling—applying it to a nonsense word he devised in his head—he maintained that *Finnegan's Wake* was a novel he knew well, having first encountered it when he was ten years old and revisiting it for "occasional perusals" thereafter.[33] Perhaps Gell-Mann did not have Uhura's nearly perfect recall of the text, but he resorted to it when needing to confine his speculative particles in a word that, while suggesting literary significance, exceeded the familiar and the intelligible. For Uhura as well, this is the virtue of Joyce's estranging language, for it allows the *Enterprise* to transmit secret information and "scientific terms" in plain sight. It is a language that performs intertextual entanglements, demanding interpretation. As Uhura says, "Nobody's ever *dead* sure of what Eurish means . . . But I can probably read more of it than the Klingons could. To them, it'll be pure gibberish" (49).

Over and again, the novel emphasizes the indebtedness of the high-tech future to literary history. Spock refers to Shakespeare's *Othello* (1603) and Milton's *Paradise Lost* (1667), Kirk gestures to Conan Doyle's Sherlock Holmes stories (1887–1927), and Scotty recalls the Hobbit concept of useless "mathoms" from Tolkien's *The Lord of the Rings* (1954–55). Blish's own oeuvre is invoked several times; for example, a Klingon remembers the Xixobrax Jewelworm, which is a nod to "This Earth of Hours" (1959). Likewise, when Scotty describes the *Enterprise*'s transporter, he notes it is a Dirac technology: "What the transporter does is analyze the energy *state* of each particle in the body and then produce a Dirac jump to an equivalent state somewhere else" (3). The transporter thus joins other Dirac technologies that populate Blish's fic-

[33] Gell-Mann, "Schematic" (cit. n. 18); Gell-Mann, *The Quark* (cit. n. 22), 180. See also Johnson, *Strange Beauty* (cit. n. 21), 43, 214; Peter Middleton, *Physics Envy: American Poetry and Science in the Cold War and After* (Chicago, Ill., 2015), 51–9. On Eurish (a term Joyce never used), see Anthony Burgess, *Re Joyce* (New York, N.Y., 1965). On Blish's frequent allusions to Joyce, see Grace Eckley, "*Finnegan's Wake* in the Work of James Blish," *Extrapolation* 20 (1979): 330–42; and Ketterer, *Imprisoned* (cit. n. 31), 19, 96–8.

tions. These include the spindizzy engines of the *Cities in Flight* series (1955–62), which achieve antigravity and faster-than-light speeds by virtue of the "Blackett–Dirac equations"; the faster-than-light ship in "Detour to the Stars" (1956) and "Nor Iron Bars" (1957) that behaves as a Dirac hole; and, of course, the Dirac communicator. The Dirac communicator appeared in several stories following "Beep," including the *Cities in Flight* sequence, *Midsummer Century* (1972), and *The Quincunx of Time* (1973), an expansion of "Beep" that would be Blish's final novel before his death in 1975. Offering a subtle reminder that Blish had fabulated things that go faster than light throughout his career, *Spock Must Die!* represents a reclaiming of tachyons. It recycles these particles "for which nobody's ever found any use" in a story that is literally about a struggle over creative priority, set in a future where tachyonic duplication has threatened to reverse the proper order of things.

But the point of *Spock Must Die!* is not simply that the future inherits from the past, that new scientific propositions as much as literary fictions swipe from earlier cultural resources. It also suggests how the past inherits from the future, reinterpreted in light of new developments that drive further speculation, further innovation. For instance, the original Spock does not, at first, understand how his twin created a portable warp drive to draw energy from Hilbert space. But after investigating, Spock comprehends how the trick was accomplished, and he sees a path forward to even greater feats: "Anything the replicate could do, I can probably do better" (104). In other words, the adaptation compels the original to catch up, to go further: a game of modifiable futures that both Blish and Feinberg knew well.

PROMETHEAN PROJECTIONS

Around the same time, and playing the same game, Feinberg proposed an ambitious global endeavor that he called the Prometheus Project. He sketched out this proposal in his 1968 book, *The Prometheus Project: Mankind's Search for Long-Range Goals*, and he continued to develop these ideas over the following decade, reiterating them in his 1977 book, *Consequences of Growth: The Prospects for a Limitless Future*. The Prometheus Project was to be a scheme for reshaping social organization to achieve futuristic visions. In effect, Feinberg proposed establishing an Event Police, governing the future in the image of science fiction.

In his books, Feinberg imagines a widespread democratic process, involving stakeholders from all over the world, in which a variety of long-range future scenarios are deliberated to help our species pursue desirable sociotechnical pathways and avoid catastrophic ones: "The purpose of this book is to propose a group effort, which I call the Prometheus Project (from the Greek word *prometheus*, meaning foresight), by which humanity can choose its goals. . . . In that way, humanity would move closer to becoming the shaper of its own destiny."[34]

According to Feinberg, the accelerating entanglements of globalization and technologization indicate that choices we make today might prove to be "world-shaking decisions" with "irreversible effects" (19). He points to nuclear technologies and climate effects of industrial pollution as known instances of such world-shaking decisions, claiming that even more profound eventualities will arise. "The advent of 'world-

[34] Gerald Feinberg, *The Prometheus Project: Mankind's Search for Long-Range Goals* (Garden City, N.Y., 1968), 13–4. Further page citations appear parenthetically in the text.

shaking decisions,'" he argues, "thus calls for some kind of long-range planning of the future of mankind. Otherwise man, having elevated himself through his technology from being the plaything of blind nature, might become the victim of blind actions on his own part" (20–21).

Such long-range planning would involve collective assessment of various "as if" scenarios, technological and scientific developments that might utterly change society, the natural environment, or human biology. It would mean committing as a global civilization to certain goals and affirmatively answering the question, "Should we, the people alive today, bind the people of the future to our own purposes, and can we do so?" (25).

Necessarily speculative, such a massive project would benefit tremendously from drawing on one of our best resources for assessing the future impacts and potentialities of technoscientific innovations: namely, science fiction. "It is unfortunate," Feinberg writes, "that these imaginative writings have not been given much serious attention, since they are not only a fertile source of suggestions for goals, but also often point out unexpected implications that the attainment of some goals might have for human life" (18).

Among the many "as if" scenarios presenting themselves with particular intensity, Feinberg notes the unprecedented possibilities for reengineering the human body and human behavior though new tools of biotechnology and cognitive science. "Human nature is therefore not something unalterable," he writes, "but can be changed" (29). He cites several novels including A. E. Van Vogt's *Slan* (1946), Olaf Stapledon's *Last and First Men* (1930), Jack Williamson's *Dragon's Island* (1951), and others as providing insightful assessments of these issues, helping to frame the scope of further developments.

But Feinberg asserts that our capacities to speculate and deliberate on "the option of changing man" (27), and to anticipate even a small fraction of the ramifications, are circumscribed in advance—limited by human nature itself. Human, all too human. For this reason, the Prometheus Project proves to be a self-reflective critical assessment of human being, the constitutive finitude of humannness that prevents us from seeing much beyond our own presentist horizon. As Feinberg writes: "The most serious fault in the human condition lies in our finitude. We are conscious beings aware of our own limitations. Two of the most important of these are the lack of power to do things we want to do, and the specter of impending death, which always threatens to put an end to all our thinking and doing" (43).

The difficulties of securing a sustainable, desirable future ultimately reduce to the limits of human agency and foresight—the blinders of short-term thinking imposed by the span of a single human lifetime—which encourage us to push unforeseen problems onto later generations. According to Feinberg, the solution is to overcome these limits, these so-called ends of man. This would first mean mobilizing our best science and technology toward the elimination of death as an obstacle, taking "steps toward indefinite life and youth" (45). But merely eliminating death as a natural limit would not solve the seemingly more intractable problem of the metaphysics of presence, or what Feinberg calls the "temporal provincialism inherent in most human thought."[35] So, we must go further to overcome not only the condition of being-toward-death, but

[35] Gerald Feinberg, *Consequences of Growth: The Prospects for a Limitless Future* (New York, N.Y., 1977), 94.

also being-as-presence: "Perhaps the only true solution to the problem of death is to eliminate it for those who do not desire it. . . . But even 'at death's end' men will remain finite beings in their accomplishments if not in their expectations. . . . [So,] some other kind of reconstruction of man appears called for to deal with finitude."[36] It calls for the complete reconstitution of the human, beyond humanism and its ends: "The most radical proposals along these lines would be that man should reconstruct his biological and psychological nature so that the present faults in his condition are corrected. If this road is chosen, it means that we will have accepted the fact that not only is nonhuman nature subject to man's will in how it is to function, but that man has the choice of what he himself is to be. Such an attitude is perhaps a logical extension of setting goals for humanity" (510). The goals, the ends of humanity, now exceed humanity as such.

While conceding that others may disagree, Feinberg ventures that "changing man" is a "logical extension" of projecting our foresight into the long-term future—in other words, it is inherent to the Prometheus Project. For the social necessity of engaging in widespread deliberation about whether we *ought* to reengineer ourselves—to commit ourselves to "the biological reconstruction of the human race" (16)—leads to the conclusion that we *must* do so, if we are to have any hope of grappling with the implications of our emerging technical powers. "Changing man" becomes already inevitable, recursively transposed on the present. The "as if" future destines itself, secured by the forces of the Prometheus Project and its stakeholders who will effectively become the Event Police. Or, as Feinberg puts it, "More than ever before, we have the power to *determine* the future, rather than to predict it."[37]

Yet vigilant policing would prove unnecessary, for once begun, this imagined future becomes self-reinforcing: "If mankind is transformed through conscious biological manipulation, the new men that are produced will have a different set of interests and potentialities than we do. In making this change, we will therefore have started on a road that could not easily be retraced, not because the biological manipulation could not be undone, but because the new man is not likely to wish to reintroduce the attributes of contemporary man in himself. . . . Hence biological engineering is likely to lead to some of the irreversible changes we have discussed."[38]

With its extreme vision of refashioning human biology and behavior, Feinberg's Prometheus Project contributed to an ongoing conversation about the high-tech acceleration of human evolution, a discourse situated at the intersection of science fiction and popular science. Kickstarted in the early twentieth century by works of speculative science such as J. B. S. Haldane's *Daedalus, or Science and the Future* (1924) and J. D. Bernal's *The World, the Flesh and the Devil* (1929), the discourse of evolutionary futurism became increasingly prominent through a succession of famous texts, including Manfred Clynes and Nathan Kline's "Cyborgs and Space" (1960), Robert Ettinger's *The Prospect of Immortality* (1964), and F. M. Esfandiary's *Up-Wingers* (1973), as well as later works such as K. Eric Drexler's *Engines of Creation* (1986), Hans Moravac's *Mind Children* (1988), and Ray Kurzweil's *The Singularity Is Near* (2005).[39]

[36] Feinberg, *Prometheus* (cit. n. 34), 47. Further page citations appear parenthetically in the text.
[37] Feinberg, *Consequences* (cit. n. 35), 8.
[38] Feinberg, *Prometheus* (cit. n. 34), 67.
[39] See J. B. S. Haldane, *Daedalus, or Science and the Future* (New York, N.Y., 1924); J. D. Bernal, *The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational*

In the 1970s, taking a cue from Feinberg, the literary theorist Ihab Hassan associated this entire discourse with the figure of Prometheus. In his 1973 essay "The New Gnosticism: Speculations on an Aspect of the Postmodern Mind," as well as in his 1977 essay "Prometheus as Performer: Toward a Posthumanist Culture?," Hassan reflected on the intensification of technoscientific ambition, pointing to Feinberg's Prometheus Project among other examples as indexing a growing urgency, a transcendental yearning: "The postmodern Prometheus reaches for the fire in distant stars."[40] If the ancient myths of Prometheus once allegorized the invention of the human, the *originary technicity* of human nature—Hassan would have agreed with the philosopher Bernard Stiegler on this interpretation—the resurgence of Promethean enthusiasm in postmodernity suggested a re-visioning of humanity and humanism entirely.[41] It heralded an overcoming of physical and metaphysical constraints that Hassan, with notable irony, ventured to call *posthumanism*: "We need first to understand that the human form—including human desire and all its external representations—may be changing radically, and thus must be re-visioned. We need to understand that five hundred years of humanism may be coming to an end, as humanism transforms itself into something that we must helplessly call posthumanism." Hassan was among the first critics to diagnose a posthumanist turn in Western culture, characterized by the exercise of Promethean foresight, science fiction driving scientific practice: "Because both imagination and science are agents of change, crucibles of values, modes not only of representation but also of transformation, their interplay may now be the vital performing principle in culture and consciousness—a key to posthumanism."[42]

Feinberg certainly understood the Prometheus Project in the context of a broader discourse of posthumanism.[43] Starting in the 1960s, he advocated for a variety of forward-looking endeavors that mixed science and science fiction to recalibrate the limits of human being. For example, in 1966, he published an article in *Physics Today* called "Physics and Life Prolongation" that elaborated the scientific arguments in support of Ettinger's cryonics program. While death remains a dilemma, Feinberg agreed with Ettinger that it was just a matter of time—so freezing yourself now in

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Soul (London, 1929); Manfred Clynes and Nathan S. Kline, "Cyborgs and Space," *Astronautics*, September 1960, 26–7, 74–5; Robert C. W. Ettinger, *The Prospect of Immortality* (Garden City, N.Y., 1964); F. M. Esfandiary, *Up-Wingers: A Futurist Manifesto* (New York, N.Y., 1973); K. Eric Drexler, *Engines of Creation* (Garden City, N.Y., 1986); Hans Moravec, *Mind Children: The Future of Robot and Human Intelligence* (Boston, Mass., 1988); and Ray Kurzweil, *The Singularity Is Near* (New York, N.Y., 2005).

[40] Ihab Hassan, "The New Gnosticism: Speculations on an Aspect of the Postmodern Mind," *boundary 2* 1 (1973): 546–70, on 555; Hassan, "Prometheus as Performer: Toward a Posthumanist Culture?" *Georgia Review* 31 (1977): 830–50.

[41] Bernard Stiegler, *Technics and Time, 1: The Fault of Epimetheus*, trans. Richard Beardsworth and George Collins (Stanford, Calif., 1998).

[42] Hassan, "Prometheus" (cit. n. 40), on 843, 838. For Hassan, science fiction made visible the accelerating convergence of science and imagination, myth and technology; see Hassan, "The New Gnosticism" (cit. n. 40), 565, 567.

[43] On posthumanism in the history of science, see N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago, Ill., 1999); Mark B. Adams, "Last Judgment: The Visionary Biology of J. B. S. Haldane," *J. Hist. Biol.* 33 (2000): 457–9; Richard Doyle, *Wetwares: Experiments in Postvital Living* (Minneapolis, Minn., 2003); Colin Milburn, "Posthumanism," in *The Oxford Companion to Science Fiction*, ed. Rob Latham (Oxford, UK, 2014), 524–36; and Andrew Pilsch, *Transhumanism: Evolutionary Futurism and the Human Technologies of Utopia* (Minneapolis, Minn., 2017).

hopes that science might resurrect you in the future seemed a gamble worth taking. He suggested that the "results of low-temperature biology (cryobiology) open the possibility to those living of taking advantage of this progress before the problems of aging and death are solved."[44] For the cryonics community, alas, it is a tragedy that Feinberg did not actually commit his own mortal remains to the freezer when he died of cancer in 1992.

In the late 1980s, Feinberg also joined the Board of Advisors of the Foresight Institute—an organization founded in 1986 by Eric Drexler and Christine Peterson (at the time, husband and wife) to promote research in nanotechnology and develop policies for its development. Having read Drexler's *Engines of Creation*, Feinberg became convinced that nanotechnology would dramatically change human life—indeed, it was already inevitable. In line with his thinking about the Prometheus Project, Feinberg indicated that emerging governance efforts around nanotechnology were behind schedule before they started—the Event Police were now playing catch-up with the future. "We've already lost more time than we can afford," he said. To prepare society for the upheavals of nanotechnology, Feinberg worried that "it may already be getting to be too late."[45]

Feinberg's abiding concerns about time and timeliness—the sense that, when it comes to irreversible decisions, we may already be out of time—reinforced the posthuman dimensions of his thought. To be sure, his project of setting forth science-fictional scenarios that preemptively transform the present instantiates a posthumanist *temporalization*, reordering the classical relations of present and future, disorienting the path "from where man is now to what he will become." After all, this path sometimes might appear to move backward instead of forward, or rather, the temporal frame becomes undecidable. In *The Prometheus Project*, for example, Feinberg discusses the possibility of a human hive mind:

> In a sense, developmental and transcendent goals might be regarded as successive stages in a process of going from where man is now to what he will become. But this may not be the order in which things will or should be done.
>
> The formulation of transcendent goals is difficult because the lack of models makes it hard to imagine what conditions would really be like in the new situation. Consider, for example, the proposal that men would be much better off if they all shared a common consciousness, perhaps through something like an artificial telepathic communication system. While it is possible to describe this in words, and perhaps even to carry out the plan, it is very difficult to feel intuitively what life would be like for those who lived under these conditions. (96–97)

As Feinberg says, while it might seem that this process is about extending a developmental program—a prosthesis of the human present—into the transcendent future,

[44] Gerald Feinberg, "Physics and Life Prolongation," *Phys. Today* 19 (1966): 45–8, on 45.

[45] Feinberg quoted in Dan Shafer, "Feinberg Anxious for Policy Discussions," *Foresight Update* 9, 30 June 1990, http://www.foresight.org/Updates/Update09/Update09.1.html. On Feinberg's involvement with cryonics, nanotechnology, and other speculative sciences, see David Kaiser, *How the Hippies Saved Physics: Science, Counterculture, and the Quantum Revival* (New York, N.Y., 2011); W. Patrick McCray, *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (Princeton, N.J., 2012); and McCray, "Physics at the Frozen Fringe," *Leaping Robot Blog*, 3 February 2015, http://www.patrickmccray.com/2015/02/03/physics-at-the-frozen-fringe/. On the rhetoric of the "already inevitable" in nanotechnology and its posthuman implications, see Colin Milburn, *Nanovision: Engineering the Future* (Durham, N.C., 2008).

gradually turning imagination into actuality in linear historical time, the situation is quite otherwise ("this may not be the order in which things will or should be done"). While it might be possible to "carry out the plan" of creating a human hive mind, the actual experience of such collective consciousness cannot be known beforehand. Feinberg recalls that writers such as Olaf Stapledon have presented imaginative accounts "in words" of the expansion of human consciousness beyond its native boundaries, but what it would feel like remains inscrutable to merely human minds. All we can know now is that it would profoundly change us. Indeed, it would have effects that we cannot foresee even when contemplating the goal, with all its fictive qualities. As Feinberg notes, we have the power to determine this future, rather than to predict it. The Event Police, after all, can only operate through the logic of the "as if."

Yet for precisely this reason—namely, that it would be a "world-shaking decision" with irreversible consequences—the pursuit of such a goal would require us to change ourselves *already in advance*, to think beyond our own limits and preadapt ourselves to what is to come: "The time scale of a few centuries and the knowledge of where we are trying to go make it possible for us to adapt our social institutions to the situation when the new form of consciousness becomes a reality." According to Feinberg, we must preemptively reorganize society and ourselves for the future—and there's no time like the present: "One of the things we could do soon . . . would be to begin thinking about what kind of society would go with the new forms of consciousness" (153).

In this manner, the long-term future would appear not merely as the outgrowth of near-term developmental steps, but vice versa. This speculative future urgently solicits a reordering of society in such a way that the more specific goal of expanded consciousness becomes virtually inexorable; the consequential fiction of the hive mind sets the conditions for its own actualization. The long-term goal is not the end, but the beginning. Or rather, cause and effect become undecidable, open to reinterpretation. As Feinberg suggests, once we reshape our expectations in this way, actively preparing society for an imminent posthumanization, other goals emerge that were not seen in advance but prove to have been inevitable all along, including "the extension of consciousness to its logical limit, when it becomes coextensive with the universe" (104). At this limit we would be unlimited, in excess of ends—transfinite.

For Feinberg, the goals we set are not ends but preconditions for other modes of becoming that we cannot fully predict, and these retrospectively become our destination. Our self-transformation through long-range speculation becomes an opening to futurity, radical potentiality. Feinberg's project is not a visioning program that sees the future as merely a prolongation or metastasis of the present, but instead represents an eversion of the future, aspiring to bypass the failures of the human and its being-toward-limits.

We might note that this excession of ends, as an onto-epistemological transformation of the human condition, parallels the structure of Feinberg's analysis of tachyons as particles already beyond the speed limit of light, already beyond the relativistic barrier that secures the classical principle of causality—and whose propagation backward or forward in time, as either cause or effect, would be fundamentally undecidable. Hence, the reinterpretation principle allows us to see future events as affecting the past only in the sense of the "as if."

In this regard, once again, James Blish would seem to be at the root of Feinberg's posthumanist project. But it is not Blish alone. Rather, it is science fiction as such,

which characteristically bodies forth a Prometheanism in advance of itself, a *preposterous* Prometheanism. As indicated by the history of the genre, from Mary Shelley's *Frankenstein; or, The Modern Prometheus* in 1818, to Ridley Scott's film *Prometheus* in 2012, science fiction presents itself as a projection of foresight that becomes the precondition for looking backward—looking inward at ourselves . . . preposterously, without end.

PREPOSTEROUS FICTIONS

Consider, for example, the work of Arthur C. Clarke. While Feinberg does not directly cite Clarke's fiction in *The Prometheus Project*, he does discuss the author's 1962 nonfiction treatise, *Profiles of the Future*, which attends to the crucial role of speculative fiction for technoscientific progress: "The only way of discovering the limits of the possible is to venture a little way past them into the impossible."[46] Moreover, there are moments in *The Prometheus Project* when Feinberg considers the possibility of alien influences fostering our posthuman evolution—a recurring concept in Clarke's fiction, beginning with his 1953 novel *Childhood's End*.[47] To be sure, *Childhood's End* was one of Feinberg's favorite novels, and he often recommended it to other scientists.[48] Feinberg's interest in this particular novel also helps to explain why he sent his tachyon manuscript to Clarke in 1967, because the main plot twist involves information traveling backward in time. In any case, the literary conceits of Clarke's novel prefigure the approach to posthumanization in *The Prometheus Project*.

When the Overlord ships arrive at the beginning of *Childhood's End*, the event signals both recollection and prolepsis, both *déjà vu* and preview: "There had been no warning when the great ships came pouring out of the unknown depths of space. Countless times this day had been described in fiction, but no one had really believed that it would ever come. Now it had dawned at last; the gleaming, silent shapes hanging over every land were the symbol of a science that man could not hope to match for centuries."[49] The arrival represents a high-tech future incongruously transposed into the human present ("the symbol of a science that man could not hope to match for centuries"), recalling an entire narrative genre conspicuously preoccupied with such events ("Countless times this day had been described in fiction"). The arrival of the alien Overlords symbolizes science fiction as such, a recursive figuration with all its generic clichés as well as its conceptual innovations. Or, to say it differently, the arrival of the Overlords takes the form of science fiction—it is a science-fictional event—even within the world of the novel. Furthermore, the discourse of science fiction has prescripted the experience of so-called first contact. One character even re-

[46] Arthur C. Clarke, *Profiles of the Future: An Inquiry into the Limits of the Possible* (New York, N.Y., 1962), 21.

[47] Arthur C. Clarke, *Childhood's End* (New York, N.Y., 1953). Clarke continued to explore this idea in other narratives, including *2001: A Space Odyssey* (1968) and its sequels.

[48] For example, the physicist Jeremy Bernstein recalled that Feinberg recommended *Childhood's End* to him in the early 1960s; Jeremy Bernstein, "The Grasshopper and His Space Odyssey," *Amer. Sch.* 77 (2008): 154–7. Feinberg's recommendation led to Bernstein striking up a friendship with Clarke and writing one of the earliest overviews of Clarke's career; Jeremy Bernstein, "Out of the Ego Chamber," *New Yorker*, 9 August 1969, 40–65.

[49] Clarke, *Childhood's End* (cit. n. 47); quotation here is from the Del Ray Impact edition (New York, N.Y., 2001), 13. Further citations of the Del Ray Impact edition appear parenthetically in the text.

bukes another for holding preconceived notions about the Overlords: "You . . . have been reading too much science-fiction" (21).

Even long after their arrival, the Overlords hide their true appearance from human eyes, because they recognize that the entire history of myth, fantastical literature, folkloric and religious tradition—the prehistory of science fiction in the largest sense—has prejudiced the human species against them.[50] For the Overlords look like demons: "There was no mistake. The leathery wings, the little horns, the barbed tail—all were there. The most terrible of all legends had come to life, out of the unknown past" (71).

Once the Overlords reveal their true forms, a number of human scholars theorize that some horrific situation in ancient history, some aboriginal encounter between the Overlords and our ancestors, must account for the instinctual human fear of demonic figures. Yet the reality is more shocking. As it turns out, the appearance of the alien other in the long history of folklore and mythology does not record ancestral memory. Instead, it records *futurity*—a prescription or program of events yet to come. For the Overlord's secret purpose is to shepherd the orthogenetic evolution of *Homo sapiens* into something more than human, guiding social and biological conditions toward the emergence of the posthuman.

The ancient fear of demonic figures and monstrous others, as recorded in the genealogy of fantastical literature, proves to have been a memory in reverse—a psychic adjustment to the posthuman future. The human apperception of its own closure, the end of its childhood, has therefore been narrated since time immemorial. The Overlords explain, "For that memory was not of the past, but of the *future*—of those closing years when your race knew that everything was finished. . . . And because we were there, we became identified with your race's death. Yes, even while it was ten thousand years in the future! It was as if a distorted echo had reverberated round the closed circle of time, from the future to the past" (225–26). Fables of satanic possessions, monstrous births, and alien invasions prove to have been letters from the posthuman future, though we did not recognize them in time.

Clarke's novel depicts the genealogy of fantastical stories as a series of distorted messages, misunderstood allegories of the human engagement with world-changing forces. Recursively situating itself in this literary history, *Childhood's End* represents a final, undisguised account of the end of human existence and its transmutation into something unspeakably other. But the narration also thematizes its own belatedness, the sense in which its full implications may remain indecipherable in the present. Jan, the lone human witness to the ascension of posthumanity, remains on Earth even after the Overlords themselves have fled to safety. He records his observations with a telephonic device, describing the final moments of the doomed planet in his own words: the last human narrator, reporting from the edge of apocalypse. Jan's words are transmitted to the Overlord ship, helping the aliens to imagine a posthuman event that they cannot witness directly. However, due to the time delay in relaying messages to a ship

[50] On science fiction's continuity with mythic and religious discourse, see David Ketterer, *New Worlds for Old: The Apocalyptic Imagination, Science Fiction, and American Literature* (Bloomington, Ind., 1974); Alexei Panshin and Cory Panshin, *The World Beyond the Hill: Science Fiction and the Quest for Transcendence* (1989; repr., Rockville, Md., 2010); Thomas M. Disch, *On SF* (Ann Arbor, Mich., 2005); Jeffrey J. Kripal, *Mutants and Mystics: Science Fiction, Superhero Comics, and the Paranormal* (Chicago, Ill., 2011); and Adam Roberts, *The History of Science Fiction*, 2nd ed. (London, 2016). The extent of science fiction's relationship with myth has been much debated. Clarke's novel imaginatively resolves the debate by rendering it into an explicit plot element.

traveling near light speed, the Overlords receive Jan's narration of the posthumanizing process long after it has concluded, long after the last man himself has been absorbed by the transformative energies: "It was strange to think that the ship of the Overlords was racing away from Earth almost as swiftly as his signal could speed after it. Almost—but not quite. It would be a long chase, but his words would catch [them]" (232).

As usual, the posthuman narrative comes too late, always playing catch-up. Even when sent early, it proves legible only after the fact. It addresses a destination that it has not yet reached, depicting a future that has already taken place. Which is to say, Jan's transmission—his words racing ahead, looking backward on what will have been—has all the characteristics of science fiction.

Childhood's End offers a parable about speculative narratives that presage and inform the circumstances of their own actualization, even if they appear a bit off schedule. So it's really no wonder that Feinberg was such a fan. His practice as a theoretical physicist and science policy advocate seems to have taken seriously Clarke's trope of literary precognition—a distorted memory of the future that, while it may appear as fantasy and make-believe, nevertheless conditions the future as it arrives. If nothing else, as a metaphor, Clarke's idea that speculative fiction might both record and distort genuine precognition—recognized only belatedly—resonates with Feinberg's endorsement of the "as if" method for scientific innovation.

Indeed, he applied the same approach when taking Clarke's metaphor literally. In 1974, Feinberg contributed a paper called "Precognition: A Memory of Things Future?" to a conference in Geneva, Switzerland on "Quantum Physics and Parapsychology." Similar to his assessment of tachyons, Feinberg granted that precognition may not be a real phenomenon, but he nevertheless offered "a very speculative model for precognition," complete with testable hypotheses that would encourage further research to better understand the model and its implications for physics in general—the mode of the "as if":

> I am suggesting that precognition, if it exists, is basically a remembrance of things future, an analogy to memory, rather than a perception of future events, an analogy to sense perceptions of the very recent past. This suggestion has at least the merit of being fairly easy to test through simple experiments . . . If it is correct, it would not directly indicate the physical mechanism for precognition, any more than the existence of memory indicates its physical mechanism. However, if it does turn out that memory can operate into the future as well as into the past, it would suggest that the symmetry of physical laws . . . is involved, and that physicists have been premature in discarding those solutions to their equations that describe reversed time order of cause and effect.[51]

Preemptively claiming stakes on any science of precognition yet to emerge, Feinberg also pointed out that, should his speculative model prove viable, the practice of excluding perplexing solutions to physical equations as well as the scientific consensus on classical causality would both need to be revised. As in his work on tachyons, Feinberg indicated how scientific speculations—whether theoretical constructs or preposterous fictions—might afford new ways of looking at the actual practices of science, rethinking received knowledge, and imagining alternatives, even if only to bet-

[51] Conference paper published as Gerald Feinberg, "Precognition: A Memory of Things Future," in *Quantum Physics and Parapsychology*, ed. Laura Oteri (New York, N.Y., 1975), 54–73.

ter recollect how it is that we know what we know. For Feinberg, the science fiction way of doing science was never about predicting the future, as such. Rather, it was about attentively establishing the conditions in which the future could take place, unrestrained by the present and its limits, the known and the familiar: an open solicitation of realizable worlds and the shape of things to come . . . ahead of time.