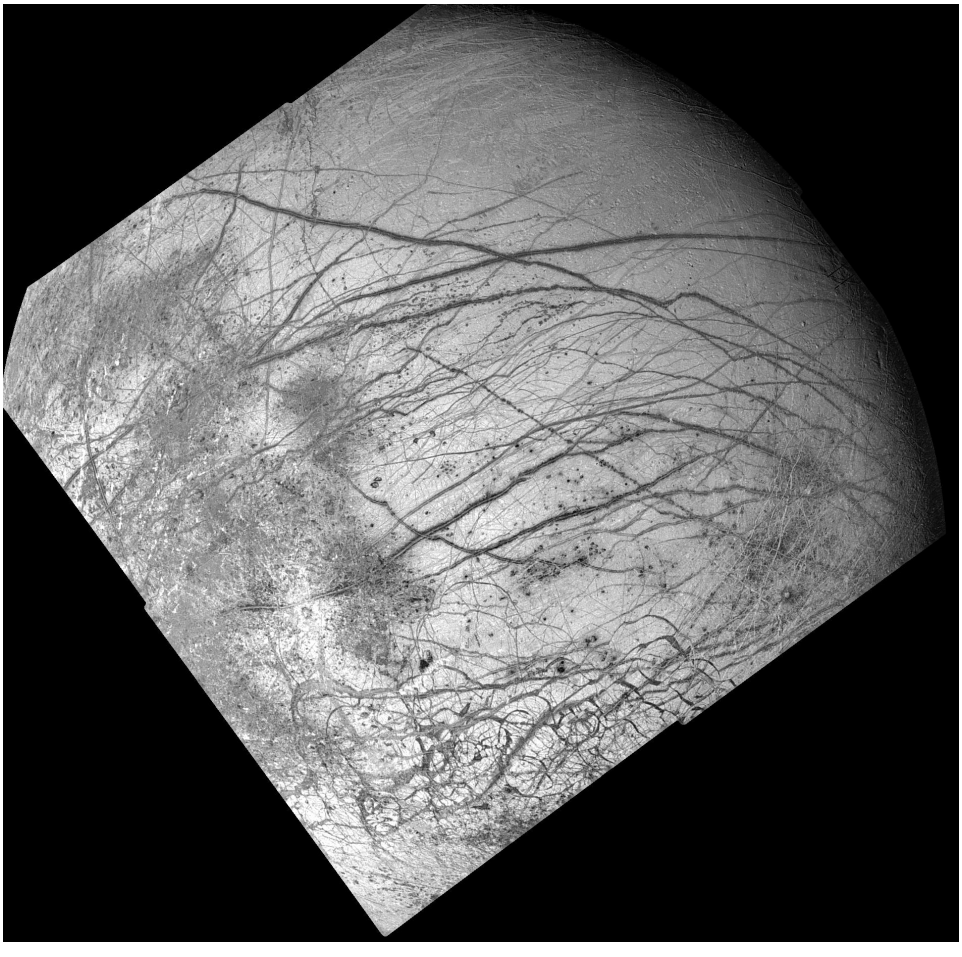

Photomosaic of fractured and smooth regions on the surface of Jupiter's icy moon, Europa, as imaged by the robot spacecraft *Galileo* during a 1996 flyby. Image: Galileo Project, JPL, NASA.

The Signature of Life: Designing the Astrobiological Imagination

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Century's Turn

In *Century's End,* Hillel Schwartz writes that Mars came into focus at the end of the nineteenth century as fin de siècle anxieties propelled people to look toward the red planet for clues about the past and future of life on Earth.[1] Percival Lowell saw canals on Mars, which he read as signs of a once great but now dying civilization. H.G. Wells, in *The War of the Worlds,* scripted Mars as the dystopic destiny of industrial-age Earth; his invading Martians were vampiric machines embodying the worst excesses of capitalism. Schwartz tells us, too, that the poles, the Arctic and its double, Antarctica—twin origin points for zero-degree orientation and snow-blind disorientation—have also featured in centurial meditations on life and its limits. In Kurd Lasswitz's 1897 science fiction *Two Planets,* fantasies of Mars and the poles converge when balloonists discover a conduit between the North Pole and Mars, maintained by an advanced Martian civilization.

Schwartz predicted that Mars and the poles would again come into view around the turn of the last century—a forecast more than borne out by public fascination in 1996 with fossil-like remains found in Martian meteorite ALH84001, discovered in Antarctica.[2] In Spring 2001, a publication appeared that neatly fulfilled Schwartz's prognostications: the first issue of the scientific journal *Astrobiology*.[3] This number was filled with speculations about bacterial life at the Martian poles and below the icy shell of Jupiter's satellite Europa. An interesting reversal had taken place with this second coming of Mars and the frozen limits, however. In *The War of the Worlds,* invading Martians were brought low by terrestrial microbes. According to an *Astrobiology* article entitled "Cave Biosignature Suites: Microbes, Minerals, and Mars,"[4] however, the latest news from biologists of the extraterrestrial seems to be that Martians, if they do exist, may *be* microbes.[5] The search for microbes on Mars has recently drawn new audiences, most notably with the 2004 arrival on Mars of NASA's remote-controlled exploration rovers *Spirit* and *Opportunity,* which began

to scribble the surface of the red planet with tire tracks, scouting for signs of water. Europa's ice, meanwhile, has retained the allure of the extreme—though, in a transposition not surprising in disquisitions about vertiginous frontiers, this heavenly body has become appealing primarily because it may conceal, beneath its cracked crystal shine, hot baths of hydrothermal vents harboring extremophilic, chemosynthetic microbial life.[6]

"Astrobiology," thrice coined with little result before denominating the new journal—once in 1941 by Laurence Lafleur in a long-forgotten leaflet of the Astronomical Society of the Pacific; once in 1955 by Otto Struve, who immediately believed biology too immature to speculate on cosmic life; and once in 1959 by Albert Wilson, who proposed the field as a laboratory-based simulation science (and whose discipline-building efforts were overshadowed when he cultivated connections to space medicine)—finally, in 1998, became a favored designation for the study of cosmic biology when NASA founded its Astrobiology Institute, edging out earlier disciplinary monikers such as "exobiology" and "bioastronomy."[7] The new astrobiology spends much of its time not in wet-labs experimenting with extraterrestrial analogues but in looking to other planets for what researchers call "the signature of life,"[8] or often simply a "biosignature,"[9] defined as "any measurable property of a planetary object, its atmosphere, its oceans, its geologic formations, or its samples that suggests that life was or is present. A short definition is a 'fingerprint of life.'"[10] A founding challenge presents itself here, according to astrobiologist David Des Marais, which is that researchers face the difficulty that "our definitions are based upon life on Earth" and that, "accordingly, we must distinguish between attributes of life that are truly universal versus those that solely reflect the particular history of our own biosphere."[11] This is no simple task, because knowing what is universal is precisely what is to be discovered. Astrobiologists seek to discern the signature of life through examinations of, for instance, chemical assays of extraterrestrial rocks or spectral analyses of distant planets and then "infer from the biosignatures that life is or was present."[12] Such a search for signs of life from or in the sky is kin, of course, to the practices of SETI, the Search for Extraterrestrial Intelligence, though there are important mutations, too, most of which involve the retreat from the category of "intelligence" to a substrate called "life."

In this essay, I examine the project of astrobiology and its object, the "signature of life," using the unconventional work of historian Hillel Schwartz, particularly his writing on time in *Century's End,* duplication in *The Culture of the Copy,*[13] and signification in "De-Signing."[14] Schwartz's work can give us a fresh angle on the doublings, redoublings, definitions, and redefinitions at the heart of astrobiology's quest

for extraterrestrial life.[15] Schwartz's heterodox historical method—which in *The Culture of the Copy* allows him to leap from a discussion of simulated prizefights to parrots to documentary film—proceeds, as he characterizes it, "more often by similitude than chronological lockstep."[16] His crabwise approach offers provocative paratactical techniques for traversing the networks of association, acknowledged and unacknowledged, that support the concept of the signature of life. A puzzled reviewer of *The Culture of the Copy,* finding Schwartz's approach hard to pin down, asks, "What forms of analysis become necessary when using 'similitude' as the basis of a scholarly argument?"[17] Many answers are possible, surely one of which is that, in *The Culture of the Copy* at least, similitude itself operates as an analytic apparatus demonstrating the unexpected connections and comparisons that practices of copying enable. In a nontrivial way, decisions about what counts as similitude *constitute* the analysis. Similitude-seeking also organizes much of astrobiology's quest to find life elsewhere in the universe. Astrobiology's similitudes are animated primarily by the search for the analogous, for those structures "similar in certain attributes, circumstances, relations or uses" (*Oxford English Dictionary,* Second Edition, 1989). A Schwartzian sally through astrobiology's similitude-scouting practices offers a view into the explicit and implicit logics of the enterprise, a way into thinking about the transferences associated with analogies, and a path toward thinking about how patterns of inference can be disturbed by interference from without and within.

My itinerary will be as follows: I will first glance at SETI through the optic of Schwartz's writings on copying and his current work on noise, and then turn to an examination of astrobiology's notion of the signature of life, diffracting this through Schwartz's semiotic provocations in his essay "De-Signing," which examines the afterimage of the *sign*: *de-sign,* or what he calls "the urge away from plan and plot."[18] Feeding the signature of life through Schwartz's mesh of tales about time, duplication, and noise, I shall use de-sign as a tool for making CAT scans of an astrobiological imagination that comes of age at a time when the replication and restitution of the signs of life is the order of the day in enterprises ranging from cloning to the computer simulation of living things.[19] Tinkering with Schwartz's tool kit—using it as a rhetorical Mars Rover—I conclude by offering a meditation on method along with suggestions for thwarting the overreaching of the theoretical impulse in both life sciences and humanities.

A Noisy Culture of the Copy

Astrobiology is not SETI. SETI has largely assumed that extraterrestrial intelligence will twin human cognition. When SETI has looked for signs of intelligence in the

universe, it has looked for an imitation of itself, setting up a sort of cosmic Turing test, screening for signals in a sea of noise.[20] Extraterrestrial communications, many SETI scientists believed, would copycat our own; aliens would tune into the same channels as earth scientists. Dedicated radio astronomy hams, they would be happy to join in a spaced-out signal-to-noise jam session.

With SETI, the radio telescope, like the organic electrochemical transducer of the human ear on which it was patterned, became, to borrow a phrase from Schwartz, an "actively straining medium,"[21] listening for murmurs from the cosmic beyond. This scientific sounding of the universe required tools of amplification and a patient attention to the very quiet. In this sense, SETI operationalized, in a scientific register, what were, historically speaking, relatively recent associations of quiet with spirituality. Schwartz writes that "to be 'spiritual' around 1900 was, in the most nondenominational of senses, to be receptive, contemplative, inwardly quiet. It was, in the most nonscientific of senses, to be attentive to 'vibrations' emanating from other hearts, other beings, other times."[22] Nikola Tesla, one of the first to tune in to unusual electrical disturbances, wrote that these "positively terrified me, as there was present in them something mysterious, not to say supernatural. . . . The feeling is constantly growing on me that I had been the first to hear the greetings of one planet to another."[23] SETI retained Tesla's early-twentieth-century sense of mystery, but under the stewardship of such optimists as Carl Sagan modulated his terrified response into a hopeful openness, a nondenominational attentiveness to potential *good* vibrations.

Interested in receiving a signal from the stars and partitioning out noise, SETI scientists chose wavelengths—what they called "naturally identified frequenc[ies]"—that they imagined they themselves would have chosen were they trying to communicate with aliens, which of course they were.[24] Searching for a frequency between galactic and atmospheric noise, some held that "the region of the spectrum from 1 to 3 Gigahertz (1 to 3 billion cycles per second) was the location of 'likely beacon frequencies,' in particular the portion from 1.420 GHz (the 21-cm hydrogen line) to 1.662 GHz (the OH line)."[25] Transporting symbolic associations between water and life to the skies, engineer Bernard Oliver and space doctor John Billingham explained in 1971 that "surely the band lying between the resonances of the disassociation products of water is ideally situated and an uncannily poetic place for water-based life to seek its kind. Where shall we meet? At the water hole, of course!"[26] SETI scientists would listen for the water music of the spheres.[27] Whether what they heard would resemble the chance sounds created by the avant-garde composer George Brecht in his 1959 *Drip Music*[28] or the unfamiliar but intel-

ligibly equal-tempered melodic messages imagined by astronomer Sebastian von Hoerner in his 1974 meditation on alien communication, "Universal Music?"[29] would depend on how they drew the line between sound and sense, on whether they listened simply for oceanic echoes of their own voices.

Signed, Life

Astrobiologists do not require that aliens employ technical or symbolic associations between water and life in their communications. Astrobiologists seek rather to head straight for "the signature of life," often zeroing in on the spectral trace of water as an encouraging indication of the possibility of vitality (an account of "life" that assumes it can always be found, that "life" would never have anonymity as its *modus operandi*). On the missions of *Spirit* and *Opportunity,* such assays are conducted in situ, even as reasoning by indirection and inference still saturates the search:

> Life, as we understand it, requires water, so the history of water on Mars is critical to finding out if the martian environment was ever conducive to life. Although the Mars Exploration Rovers do not have the ability to detect life directly, they will be offering very important information on the habitability of the environment in the planet's history. The rovers will focus on questions concerning water on Mars: its past, where it was located, and the chemical and geological interactions with the rocks and soil. . . . NASA will also look for life on Mars by searching for telltale markers, or biosignatures, of current and past life.[30]

What exactly *is* a biosignature? Des Marais and colleagues write in "Remote Sensing of Planetary Properties and Biosignatures on Extrasolar Terrestrial Planets" that

> A biosignature is a feature whose presence or abundance requires a biological origin. Biosignatures are created during the acquisition of the energy or the chemical ingredients that are necessary for biosynthesis or both (e.g., leading to the accumulation of atmospheric oxygen or methane). Biosignatures can also be products of the biosynthesis of information-rich molecules and structures (e.g., complex organic molecules and cells).[31]

Biosignatures, then, are traces that can be read, that require literacy in organic chemistry; indeed, that take *as read* an ontological difference between the organic and the inorganic. What reading practices are employed to make sense of such biosignatures?

According to petrologist Monica Grady, both direct and remote "signatures of extraterrestrial life"[32] might be sought. *Direct signatures* include measurements that

show evidence (in rock samples, for example) of the production of organic molecules through biological process. If a compound—like a sugar or amino acid—is present in two mirror-image versions, for instance, and one version is found in greater quantity than is another, then it is possible that disequilibrium processes of biology are responsible. The *chirality*—or "handedness"—of such *stereoisomers,* which can be determined using polarized light, can be used to infer biological activity. The asymmetries of stereochemistry can thus be a pointer to possible life; more specifically, these might be indicators that processes of metabolism are reproducing contingent asymmetries of an initial collection of compounds.[33] Similarly, if a variety of isotopes of the same element (say, carbon) are found in different instances of an extraterrestrial organic compound, this may also suggest disequilibrium processes that may be biological in origin.

Remote signatures of extraterrestrial life include such items as the spectral signature of the atmosphere, which can point toward such bioproducts as ozone or methane. Des Marais and colleagues argue that "spectral biosignatures can arise from organic constituents (e.g., vegetation) and/or inorganic products (e.g., atmospheric O_2)." Assuming that "all life requires complex organic compounds that interact in a liquid water solvent," they argue that, "life is an information-rich entity that depends fundamentally upon the strong polarity of its associated solvent."[34] This means, "Detection of O_2 or its photolytic product O_3 merits highest priority."[35] Water retains its special place in this semiotics of life.[36]

David McKay, one of the key researchers on Martian meteorite ALH84001, offers with his colleagues a ranking of different kinds of biosignatures based on their persuasiveness, arguing that *"the reliability or usefulness of a biosignature is inversely proportional to how difficult it is to produce by non-biologic processes."*[37] Category I biosignatures—akin to Grady's direct signatures—are *"nearly indisputable evidence for life,"* and examples include "complex fossils such as trilobites, skeletons, and other forms with indisputable morphologies (extremely challenging with single-cell life)." Category II biosignatures—remote signatures—include the "presence of ozone and methane in a planetary atmosphere." Category III biosignatures embrace such items as "micrometer-size spherical or ovoid objects of appropriate composition"—which last describes the shapes found in ALH84001 and might be described as *direct* but *iffy signatures.*[38]

We are in the presence here of a sign-searching practice distinct from SETI. If SETI sought signals in an ocean of noise, looking for the arbitrary and organized surprise—what scientists have come to call *information*[39]—astrobiology searches in a less Saussurian mode, a more impressionistic mood, scouting primarily for

what semiotician Charles Sanders Peirce called *indices*—indirect representations, traces, of its object, life (fingerprints and smoke are canonical Peircean indices of fingers and fire).[40]

This language of "signature" demands direct comment. Schwartz writes in *The Culture of the Copy* that signatures as signs of irreproducible authenticity "acquired their full authority only with the Romantic celebration of genius."[41] As it happens, the signature of life also celebrates a metaphysical concept—namely life itself, which Michel Foucault argues came into being as kin to the mystic individual of Romanticism.[42] But such metaphysical concepts as "genius" and "life" are haunted by an anxiety about the stability of their identity in a regime of reproducibility; the signature becomes the reproducible sign of the irreproducible, destabilizing the very conceit of irreproducible authenticity. "Life" migrates into quotation marks—not just in cultural studies of science but in recent theoretical biology as well—because it is at once so quotable and so definitionally unstable.[43] Indeed, insofar as life is known by its associated disequilibria, it is by definition definitionally unstable.[44]

A detour into Derrida brings into relief a key conundrum. In "Signature Event Context," Derrida writes that taking the signature as a trace of the authentic, of presence, depends on the absence of the signer, resulting in the error of attributing presence to signature itself: "In order to function, that is, in order to be legible, a signature must have a repeatable, iterable, imitable form; it must be able to detach itself from the present and singular intention of its production. It is its sameness."[45] On this view, the signature of life can exist only insofar as life itself is a replicable absence, a metaphysical quality we know when we don't see it. Putting it this way, however, reveals that Derrida's claim is too singular; a signature might rather be thought of as a family of differences, rendered related by witnesses that attest to their similarity, not their sameness. The paradox that then follows, as astrobiologists are more than aware, is that the search for extraterrestrial life is strongly constrained by what we have witnessed of life on earth: "Our concepts of life and biosignatures are inextricably linked."[46] The protagonist of Dave Eggers's novel, *You Shall Know Our Velocity!,* encounters an illustrative vexation when trying to cash a traveler's check: "At the currency exchange desk, I added my name . . . to twelve $100 traveler's checks and handed them under the glass wall to a glowering man. . . . The man . . . wouldn't take them; my signature did not, he said, match my passport. . . . I told him, yes, I changed my signature not that long ago, thus the mismatch."[47] One risk astrobiologists run is becoming that glowering man at the currency exchange, overlooking the mark of the unexpected traveler, ignoring what

rhetorician Richard Doyle calls "the very essence of the alien presence, its characteristic ability to proliferate and mutate, disturbing the various taxonomical categories that we bring to bear on 'them.'"[48]

To be sure, astrobiologists want to be awake to surprising multiplicity, which is one reason researcher Baruch Blumberg suggests in his official account of astrobiology that the field is open to a promiscuity of evidentiary regimes:

> Astrobiology is an interesting mixture of scientific processes. One emerges from the historical sciences that make up a large part of the astrobiology enterprise: astronomy, ecology, field biology, geology, oceanography, paleontology, and others. The events being investigated have happened, and it is the task of the scientists to tell the explanatory story. It is *inductive* science in that the data are collected first and then the hypothesis is formulated. . . . A second scientific approach emerges from the ethos of contemporary medical/biological research. It is *deductive* in the sense that it is hypothesis driven. . . . There is a strong emphasis on experimentation, in which the scientist creates his or her own universe that is, or is assumed to be, a simulacrum of the real world beyond the laboratory bench.[49]

Astrobiologists disagree, then, with nineteenth-century Nantucket astronomer Maria Mitchell, who wrote, "there is nothing from which to reason. The planets may or may not be inhabited."[50] Astrobiologists hold that there are *many* sites and logics from which to reason about extraterrestrial life—from Earth as one planet among others, from organic chemistry, from optics. Astrobiologists are even open to the idea that they might *not yet know* what to reason from. As Blumberg suggests, "life has the characteristic, using philosophical terminology, of 'being' and 'becoming.' It exists in a particular form now, but has the potential, because of the diversity in its offspring, of becoming something related, but also different."[51] Within this awareness—phrased though it is in terms of inheritance and family—is a keen sense that astrobiology is in part an enterprise that depends on what Peirce called "abduction," the argument from the future, which he described as "a method of forming a general prediction without any positive assurance that it will succeed either in the special case or usually, its justification being that it is the only possible hope of regulating our future conduct rationally."[52] Abductive reasoning appears on NASA's Mars Program Web site:

> The challenge is to be able to differentiate life from nonlife no matter where one finds it, no matter what its varying chemistry, structure, and other

> characteristics might be. Life detection technologies under development will help us define life in non-Earth-centric terms so that we are able to detect it in all the forms it might take.[53]

Abductive reasoning appears again in NASA's "Astrobiology Roadmap": "Catalogs of biosignatures must be developed that reflect fundamental and universal characteristics of life, and are thus not restricted solely to those attributes that represent local solutions to the challenges of survival."[54] Abduction, we could say, is open to the sort of surprise screamed by the astronomer Ogilvy in Jeff Wayne's 1978 disco–rock opera version of *War of the Worlds:* "The chances of anything coming from Mars are a million to one—but still they come!"[55] The question now becomes: If scrutiny of the signs of life reveals "life" to be one endpoint not just of processes of induction and deduction but of abduction, what, in contemporary biological sciences like today's astrobiology, is "life" being abducted *by*? What analogies and disanalogies guide astrobiology toward its future objects of study?

De-Signing

Schwartz can help us chart such gravitational fields of similitude. His work offers an exuberant, off-in-all-directions approach to the culture of the abducted copy, one that reads between and weaves across the lines of figures like Derrida.[56] Schwartz's approach veers away from channeling all semiotic practice into one vector of tightly coiled presence/absence, recognition/misrecognition and opens up analysis of the signature of life to the wider field of traveling anxieties and pleasures—similitudes—constituting this object. Astrobiology, after all, is founded not just on empirical commitments; it is a project that is optimistically tuned into finding life elsewhere, that earnestly believes that "life" unproblematically describes processes on earth, and that often actively seeks the shudder of realizing that we earthlings, too, are cosmic creatures.[57] If SETI has presumed aliens to be, like (some of) us, curious and well-intentioned, astrobiology assumes that extraterrestrial life forms reside in a passive and patient nature rather than in an oppositional wilderness; they are what Norbert Wiener in *Cybernetics* termed Augustinian rather than Manichean opponents.[58] In other words, McKay and colleagues' "fingerprint of life"[59] is not the trace of a careless criminal but of a comfortable homebody with nothing to hide.

Schwartz's account of the culture of the copy is extended in his "De-Signing," in which he asks us to consider the other that haunts Design, "De-Sign, the urge away from plan and plot."[60] "De-Signing," he writes, "exposes & usually opposes

the scheming found to be embedded in the word, work & world of Design."[61] For Schwartz, De-sign—a strategy, a tactic, a tendency in the arts and sciences of today—comes in eight flavors:

> 1. Defacing: overwriting design in the name of another code: "wrapping buildings, hanging graffiti in galleries, tattooing, tongue-piercing, erased lines & scratched film as graphic invention"
> 2. Displacing: removing design from the context that makes it intelligible: "collision architecture, digital photography, cyberspace, earthwork sculpture, fictive archaeologies, quick forward/reverse time fantasies"
> 3. Simplifying: reducing design in the name of common sense: "streamlining, basic black dresses, ergonomics, Zen gardens & sheetwater-over-basalt fountains in front of downtown office buildings"
> 4. Amplifying: magnifying design until it becomes caricature, monstrous, terrifying: "superrealism, heavy metal, electron microscopy, *National Enquirer* headlines, nationally inflated & pharmaceutically overwrought campaigns against obesity"
> 5. Transparency: denying design, affirming a clear reality that shines through: "glass buildings, visible plumbing & service ducts, sunshine laws, the *Reader's Digest Bible*"
> 6. Glare: subjecting design to high contrast, saturation, super-illumination: "mirrored skyscrapers, mirrored sunglasses, halogen bulbs, police helicopter spotlights, MS-NBC"
> 7. Spontaneity: interrupting design with the improvisatory: "roller coasters, impulse purchase display & advertising, Polaroids, cell phones"
> 8. Surfeit: multiplying design recursively, effacing origin and destination: "Warhol's *Sleep*, satellite TV with 480 channels, cloning, hyper-supermarkets, *Einstein on the Beach,* digital copies, octuplets surviving."[62]

Within the biosignatures astrobiologists employ—or, better, *design*—as evidence for life, do there lurk logics of de-sign? That is, having installed a representational system for detecting direct and remote signs of life, might astrobiologists also be curving away from this system, from these signs? Having set up force fields of Peircian indices, is astrobiology also being grabbed by the gravities of other similitudes? As my answer will obviously be yes, I should remark on what searching for such roving logics will accomplish. Teasing out similitudes between Schwartz's eight rhetorical energies and moments in astrobiological analysis allows us to discern semiotic fissures in the notion of "life." Such discernment is not meant as

a disabling critique of the project of astrobiology but aims rather at tracking the semantic ricochets that make vitality what it is today, when it has become imaginable to prospect for, and not just speculate about, life on other worlds.

In what follows, I read astrobiological texts through Schwartz's eight de-signs. I present this as an unbalanced list, a permutation of Foucault's Borges's "certain Chinese encyclopaedia,"[63] the fantastic classificatory grid Foucault uses to illustrate the riotous unsteadiness of the practice of taxonomy. I want to frame the multiple, sometimes contradictory features of astrobiological classification, not with the aim of fully *sorting things out,* to borrow the title of a recent book by Geoffrey Bowker and Susan Leigh Star, but of *torquing things out,* attending to the swerves and spirals that make astrobiology's object. Some of my examples highlight difficulties or contradictions in astrobiological epistemology, others the dizzy giddiness involved in searching for life in the stars, still others the interpretive complexities that texture any accounting of things biological.[64]

A killjoy might begin by saying that it is obvious that astrobiologists, in thinking life has a signature at all, believe vitality to be simple, transparent, and spontaneous and so, yes, they are de-signing, but in the most empiricist, positivist sense. Most of the signs astrobiology searches for seem to be standard indexical signs, footprints of life, signs of Yeti, not ETI. There's a lumbering literalness here that makes such de-signing unremarkable—or at least not surprising, because this empiricism by proxy has become fundamental to the natural sciences' ways of authorizing knowledge. But this analysis, of course, is too simple, so let me begin with the double vision of Schwartz's second de-sign:

2. Displacing

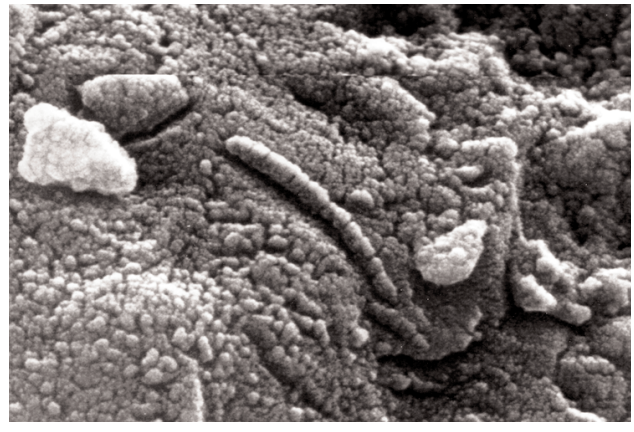
Spectrographic portraits of planets, which require differently located data points, work best if "the observer is near the orbital plane, and badly if the observer is near the orbital pole."[65] In other words, potential remote biosignatures have to be on register before they can be read—not a straightforward matter, especially for previously unknown planets, since orbital planes have themselves to be discovered through inferences that often depend on interpreting spectrographic features. Taking a cue from anthropologist Peter Redfield, who suggests in his *Space in the Tropics* that fixing an equator takes iterative semiotic work, we might say that here the signature of life risks *displacement,* a tropic turn away from sense.[66] If one is interested, for example, in using spectral imagery to surmise whether extrasolar planets harbor microbial life, getting oriented will be a potentially recursive process that will mix calibration with false positives in a cascade of difficult-to-contain displacements.[67]

3. Simplifying

The definition of life offered by astrobiologists Des Marais and colleagues—"an information-rich entity that depends fundamentally upon the strong polarity of its associated solvent [water]"[68]—trades on an urge toward *simplifying,* a forgetting of the multiple personality disorders that have haunted "life" since its historical emergence as a thing-in-itself. Simply announcing that life is wrapped up with information skims over the reductionism entailed in the idea of the genetic code, the unwritten referent in Des Marais and colleagues' definition. The transformation of DNA into a semiotic molecule—the founding mixed metaphor that transported biochemical specificity from crystallography into cryptography—is a historical accomplishment, not necessarily a fact of nature, ready to be ported across the universe.[69] To be sure, the polarity of water sits here as an ergonomic anchor for the materiality of the DNA molecule—but wait a minute, why should such a complex of wet information necessarily materialize everywhere? NASA's astrobiology Web site, in a report on the Mars Rovers, suggests that in addressing "Goal 1: Determine If Life Ever Arose on Mars," some sort of witching stick will be desirable, though no guarantee of finding life: "On Earth, all forms of life need water to survive. It is likely, *though not certain,* that if life ever evolved on Mars, it did so in the presence of a long-standing supply of water."[70] The abduction of life by information theory in Des Marais and colleagues streamlines life away from other possible articulations—as autopoietic systems for which information is only an observer's imposition, to take just one example.[71] Des Marais and colleagues' damp definition, though simple—basically, that life is smart and wet—holds water only by announcing itself as simple.

4. Amplifying

One piece of evidence advanced to support the possible biological origin of the possibly Martian microfossils on Martian meteorite ALH84001 was that on magnification these forms resembled the shape of earthly bacteria: "Ovoid features . . . are similar in size and shape to nanobacteria in travertine and limestone. The elongate forms resemble some forms of fossilized filamentous bacteria in the terrestrial fossil record."[72] This evidence, arrived at through the *amplification* of electron microscopy, offers a similitude—"similar in size and shape"—that seems to have left the object open to ridicule, collapsing this aspiring Martian into a parodic mascot for an overeager, resemblance-seeking biology.[73] Many astrobiologists balked at early pattern-matching recipes for seeing traces of life in the pictures of ALH84001. Indeed, as Robert Markley observes in his recent cultural history of research and



Ovoid forms inside Martian meteorite ALH84001, as depicted through scanning electron microscopy. The elongated shape in the center is some several hundred nanometers in length. Discussed in D.S. McKay, E.K. Gibson Jr., et al., "Search for Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001," *Science* 273 (1996): 924-930. Image: NASA.

writing on Mars, *Dying Planet,* "these photographs, first unveiled at the NASA news conference in 1996, looked like segmented biological forms and offered the same kind of challenge that Lowell's first photographs of the 'canals' had posed in 1905."[74] Resemblances to familiar structures demanded attention to the "ground"—the chemical substrate of the meteorite, the putatively watery atmosphere of Lowell's Mars—on which these figures sat magnified.

In his 1997 *Wittgenstein: On Mars,* playwright George Coates put his finger on the uneasiness that researchers skeptical about the presumptive nanobacteria in ALH84001 may have felt. Coates offered a dramatic comparison of the ovoid in ALH84001 to a famous drawing in Wittgenstein's *Philosophical Investigations,* a figure that suggests the outline of either a duck or a rabbit, depending on how one looks at it (an image later borrowed by Thomas Kuhn to illustrate the underdetermination of interpretation by evidence).[75] The Martian ovoids have become category III biosignatures—direct but iffy—and those who seek to draw them closer to being signs of life, including some of the initial researchers, have pressed for more rigorous morphological matching.[76] Others have begun to call for more chemical evidence.[77] Cady and colleagues argue that "the ALH84001 controversy underscores the need to be able to distinguish the biogenically produced characteristics of morphological microfossils from those produced nonbiologically."[78] What's more, the burden of proof now resides with researchers who would posit a biological rather than nonbiological origin for the figures—though it should be noted that the original scientists continue to claim that a biological origin offers the most parsimonious explanation. But simplicity, the previous flavor of de-sign on Schwartz's list, is not as simple as it seems. Markley notes that "in invoking Occam's razor, the two sides in the Martian meteorite debate voice different conceptions of scientific 'simplicity,' and their arguments and counterarguments reframe philosophical (and theoretical) questions about the usefulness of biological—or ecological—analogies between Earth and Mars."[79] They also raise technical questions—such as whether amplification can actually zero in on simplicity.

What Schwartz might call amplification, unsympathetic scientists may simply call exaggeration. At the same time, the playful cartoonishness of the ALH84001 ovoids directs us to the joys inherent in finding liveliness wherever one looks, as well as the fun of playing hide-and-seek with elusive Martians and credulous colleagues. Scientists are well aware of the pitfalls of analogical reasoning—even as they employ it to build hypotheses and interpret data—and astrobiologists have to be keenly on the lookout for illusory results. After all, as Kevin Zahnle writes in a 2001 review of Martian research in *Nature,* "Always life on Mars seems just beyond

the fields that we know."[80] One recent example from debates about Mars orbited around discussions of whether erosional formations on Mars that look like gullies might have been formed recently by liquid water, might be more ancient formations, or might be the result of debris carried by carbon dioxide, released from structures of ice called clathrates opened up by avalanches.[81] The treks of *Spirit* and *Opportunity* appear to have put the clathrate thesis to rest by swerving away from the technique of amplification, through measuring chemical samples instead. Close-ups, it turns out, can sometimes provide a superrealist vision that is less than clear.

5. Transparency

Which gets me to *transparency.* Looking to the optical chirality of extraterrestrial stereoisomers using polarized light is an attempt to see *through* and *into* the potentially biological, an impulse toward transparency. Here the handedness of isomers potentially points toward the invisible hand of life. Schwartz writes that "De-Sign as transparency swiftly becomes anti-metaphorical, anti-symbolic; collapsing the sign upon the signifier, it becomes uncomfortable even with simile. . . . De-Signing leads to magical discoveries of ur-languages, panhuman ethics, universal rites, syntax hard-wired in the infant brain . . . the human genome."[82] And maybe "life" as well? What sort of enchantment is at work that allows us to see vital signs shining through the mirror images of molecules? Perhaps it is similar to the enchantment analyzed by Joseph Dumit in his analysis of the visual rhetoric of brain scans, which conflate a highly mediated digitally enhanced snapshot of chemicals coursing through a human brain with a state of the brain itself and, more, with a kind of brain and person: "the symptom has been collapsed into the referent."[83] The trickiness here is that transparency—collapse—is in the techniques of the beholder. Consider, for example, this extract from a letter sent by a W. Charles Lamb from Hubbell, Nebraska, in 1928 to the scientists at the Mount Wilson Observatory in Pasadena, California: "if you will study the scriptures and the photographs, you will find probly [*sic*] more than 33 points of identity—proving the dwelling place of Gods—in The Great Nebula of Orion."[84] Seeing into or through chemical compounds in itself demonstrates nothing; optical chirality needs an account of *how* it stands for life—but this account will always be unsteady, able to condense ideas about biological disequilibrium as well as the similitude-seeking magical cosmology of readers like W. Charles Lamb. It may be no surprise that the skew toward left-handedness in most amino acids on Earth has been read by some Creationists and intelligent-design advocates as a sign of the agency of a creator rather than the result of potentially godless physical powers, like the weak nuclear force.[85]

6. Glare

This de-sign is oddly appropriate for thinking about astrobiological claims for life on Jupiter's ice-covered moon, Europa. In "Locating Potential Biosignatures on Europa from Surface Geology Observations," Patricio H. Figueredo and colleagues explain that "features on Europa tend to brighten with time."[86] Cracks in Europa's ice send up water from below, which initially darkens swaths of the surface—marking these areas as promising sites to look for life that might be flourishing beneath Europa's dead shell. Figueredo and company suggest that "because of their inferred association with transfer of briny material from or to the subsurface, low-albedo [dark], geologically recent smooth bands are among the most interesting sites for astrobiological studies."[87] But such bands are ever in danger of brightening overmuch, saturating the optical landscape so that spacecraft like *Galileo* might find their spectrometers blinded by the light (moot now for *Galileo* itself, crushed on September 21, 2003, in the shadows of Jupiter's atmosphere). Does the *glare* of the frosty disco ball of Europa dazzle with promise or blind with false hope?

We might understand in Europa's harsh light recent proposals to site on this moon's exterior a suite of magnetic sounding robots called SOUNDERs, Surface Observatories for UNDErground Remote-sensing.[88] In the switching of frequencies from light to sound, we might hear nostalgia for sonar. (Following Schwartz's history of sexuality and hearing aids,[89] might we also detect a desire for stethoscopic intimacy with this heavenly body?) In "Near-Infrared Detection of Potential Evidence for Microscopic Organisms on Europa," J. Brad Dalton and colleagues caution that, "inherent noise in the observations and limitations of spectral sampling must be taken into account when discussing these findings [about Europa]."[90] Switching from light to sound is an attempt to turn away from the glare.

Glare attunes us to the problems of visualization that inhere in many astrobiological attempts to image the signs of life on other planets. On the *Spirit* and *Opportunity* voyages, for example, from which photographs of the Martian surface have been sent back to Earth, color correction has become a key issue, especially in the search for hematite, an iron oxide, the presence of which might point toward water. NASA offers calibration details:

> When you adjust the color on your television set, you do so by picking something on the screen that you know should be a certain color (such as grass should be green) and you adjust your set accordingly. . . . The Pancam calibration target is, by far, the most unique the rover carries. It is in the shape of a sundial and is mounted on the rover deck. Pancam will image the sundial

> many times during the mission so that scientists can adjust the images they receive from Mars. They will use the colored blocks in the corners of the sundial to calibrate the color in images of the Martian landscape. Pictures of the shadows that are cast by the sundial's center post will allow scientists to properly adjust the brightness of each Pancam image.[91]

All this calibration depends of course on assumptions about how the sun and the atmosphere interact on Mars, which is not known for certain. The Earth's atmosphere can have effects too. As Jim Bell, lead scientist for the Pancam explains, "If there is rain in Spain near the Deep Space Network station, or some other communications problem, a packet of information can get distorted mid-stream and not show up at the Jet Propulsion Laboratory in Pasadena, California."[92] Glare appears again in the search for biosignatures on extrasolar planets. Roger F. Knacke writes that "the zodiacal light in an extrasolar system is a source of interference for all observations of extrasolar planets."[93] Trying to see life, we see stars.

7. Spontaneity

In "Does Life's Rapid Appearance Imply a Martian Origin?" Davies writes, "Suppose that . . . life is very hard to start (i.e., that the expectation time for life to emerge spontaneously on a suitable Earth-like planet is very much longer than the habitability duration of that planet)."[94] Building upon this hypothesis, Davies argues that Mars was habitable earlier than Earth. Mars's small size may have attracted fewer disruptive meteors and allowed it to cool more quickly than Earth, "permitting the early establishment of a deep subsurface zone in which hyperthermophilic organisms could take refuge from the bombardment."[95] Possibly, he argues, life originated on Mars and then traveled to Earth in a process he calls "transpermia" (to distinguish it from more general theories of "panspermia," associated with such figures as astronomer Fred Hoyle, which imagine life to be widespread throughout the universe). As Davies puts it, "if life emerged from a series of highly improbable chemical and physical steps, as is widely assumed by biologists, then a Martian origin for terrestrial life is probable, or even highly probable."[96] This, it seems to me, is a call for the recognition of the biological through its s*pontaneity*.[97]

To this instance of the spontaneous can be added discussions of extraterrestrial organic compounds in which the distribution of isotopes, atoms of the same element, show signs of disequilibrium. Monica Grady tells us that "one of the key aims of the Beagle 2 lander, due for launch in 2003 on board ESA's [European

Space Agency's] Mars Express, is to search for chemical traces of life on Mars, by looking for an unbalanced isotopic signature between carbon in different samples."[98] The focus on "looking for" carbon in this last example subtly suggests an astrobiological desire for cosmic company, a desire to answer in the negative the question so often on the lips of astrobiologists: "are we alone?"[99] To reply by quoting a Schwartzian similitude: "Carbon copying is, for us faithful carbon-based life forms, a prime analog of the process of replication . . . of impressing ourselves into another in the midst of making something of ourselves. The carbon copy restores to us a companionate twin, running happily along with us."[100] For readers moved by "Does Life's Rapid Appearance Imply a Martian Origin?" we have long-lost relatives on Mars. Too bad, of course, that the UK's *Beagle 2* lost its way on Christmas 2003 and is now traveling without signal on an errand into the Martian wilderness. *Beagle* cannot phone home—cannot make use, for example, of the "Beagle Ringtone" written by the British rock band Blur, which now only sounds on the cell phones of those people spontaneous enough to have double-clicked on the Web site where the ringtone could be impulse-purchased.[101]

8. Surfeit

The multiplicity of signs of life that astrobiology offers might be read not just as doubling or even triangulating on an object, "life," but as indicating that we are searching for signs of something we can define only after having defined it.[102] It might, of course, be that this very spiraling around the concept is what defines "life" at all. As Doyle observes, "'Life,' as a scientific object, has been stealthed, rendered indiscernible by our installed systems of representation. No longer the attribute of a sovereign in battle with its evolutionary problem set, the organism its sign of ongoing but always temporary victory, life now resounds not so much within sturdy boundaries, but between them."[103] The interference patterns support the mirage of vitality as a thing-in-itself, a semiotic webwork that signals "a transformation of the scientific concept of life itself, a shift from an understanding of organisms as *localized agents* to an articulation of living systems as *distributed events.*"[104] This shift is what makes the operation of similitude—the sideways travel from one concept to another—worth watching, worth mimicking, worth torquing. The off-kilter recursive logic of astrobiology—local definitions of life shape universal definitions that in turn redistribute the possibilities for local instantiations, and so on, endlessly, without finish—is the de-sign of Schwartz's *surfeit,* and he argues that the resulting indiscernibility leads to "feedback, white noise."[105]

1. Defacing

From canals on Mars to worlds on wavelengths, we are back by recirculation to Schwartz's first mode of de-sign: *defacing.* Astrobiology's claiming of the specters of the spectrum in the name of the code of life, the signature of life, is a gathering of spectrographic analysis into the project of biology. We can take a page from Michael Taussig's *Defacement,* in which he argues that it is only by becoming scribbled over that objects—here, "life"—acquire a sacred, reified status.[106] In "Year Zero: Faciality," Gilles Deleuze and Félix Guattari make a resonant argument, maintaining that the sign of the face—that collection of features we take for granted as the exterior guarantee of interior life—exists only insofar as it is a "wall that the signifier needs in order to bounce off of";[107] that is, to bounce off to produce the signified, in this case "life." The famous face on Mars, a geological feature frequently celebrated on the cover of the *National Enquirer,* is exemplary here, especially because Deleuze and Guattari write that "the face has a correlate of great importance: the landscape, which is not just a milieu but a deterritorialized world,"[108] and "the collapse of corporeal coordinates or milieus implies the constitution of a landscape."[109] And bringing together Schwartz's amplification and glare: "*The face, what a horror.* It is naturally a lunar landscape, with its pores, matts, bright colors, whiteness and holes: there is no need for a close-up to make it inhuman; it is naturally a close-up, and naturally inhuman, a monstrous hood."[110]

Ripping a page from Paul de Man, we can also see in the signature of life a moment of *prosopopeia,* a "rhetorical figure by which an imaginary or absent person is represented as speaking or acting" (*Oxford English Dictionary,* Second Edition, 1971). De Man writes that "autobiography veils a defacement of the mind of which it is itself the cause" and that "death is a displaced name for a linguistic predicament, and the restoration of mortality by autobiography . . . deprives and disfigures to the precise extent that it restores."[111] This "whirligig"[112] motion between auto/biography (self-portraiture, the signature of life) and fiction (life as it is conjectured to exist elsewhere) would, for de Man, be precisely the movement that sustains "life" at all. Thus, we might rewrite his words as: "Life is a displaced name for a linguistic predicament, and the restoration of distance by astrobiology . . . deprives and disfigures to the precise extent that it restores."[113] We have returned, it would seem, to Schwartz's displacement—to the *between* emphasized by Doyle, to the place where Schwartz's cacophony of de-signs does its work.

What do we make of all this? Is it something like a "theory" of de-signification? I'm not sure; theory may capture too much, may imprison analysis, may reduce

astrobiology to an enterprise organized around an ordinary semiotic conundrum of presence and absence. Might we resist theory—or, better, move orthogonally to it?

Athwart Theory

Schwartz, who for more than twenty years has worked as an independent scholar—that is, as a scholar outside the gravitational pull of academic departments and institutions—has sometimes been reprimanded for leaving to one side concerns that travel under the name "theory." Thus, the reviewer of *The Culture of the Copy* quoted earlier writes, "I craved more discussion and use of theory to examine, for example, how the various historical anecdotes supported or contradicted other interpretations of simulation or 'the copy.'"[114] I would say that Schwartz's work is supersaturated with theory if we understand theory—from the ancient Greek *theorein,* "to look"[115]—as inhering in his strategy of scrutinizing diverse subjects through one another.[116] Schwartz's multiplicative refractions are animated by suites of similitude pointing variously to historical lineages, symbolic resonances, accidental associations, and, sometimes, to the sheer assonance, consonance, or rhyme of words and phrases. But lest the optic of my easy etymology of *theory* be too de-signedly transparent, let me offer another angle into how Schwartz's method works in a mode I will call *athwart theory.*

Working athwart theory is not the same as writing "against theory," a practice proposed by Steven Knapp and Walter Benn Michaels some twenty years ago in *Critical Inquiry.*[117] Knapp and Michaels argued that all appeals to accounts of interpretation—whether they offered schemes for understanding everything or, on the other hand, denied the idea of correct interpretation at all—foundered on a "single mistake": the assumption that problems set up by theoretical frames were themselves real. I argue here in favor of a multiplicity of mistakes as proper guides into what is real for communities of interpretation.[118] "Theory" cannot serve as a stable frame for such interpretation. In astrobiology, for example, as Markley notes, controversies about ALH84001 have been structured "on different conceptions of what a biological 'theory' is supposed to do—offer probabilistic arguments for ancient microorganisms on Mars or present evidence that meets standards of certainty for terrestrial life-forms."[119] "Theory" is not always anyway the motive force animating astrobiological searches for signs of life.

Schwartz's sideways approach to history exemplifies what Edward de Bono has termed "lateral thinking," defined by the *Oxford English Dictionary* (Second Edition, 1989) as "a way of thinking that seeks the solution to intractable problems

through unorthodox methods, or elements that would normally be ignored by logical thinking." Such an approach operates through roving, through roaming,[120] not taking for granted a context within which a text or event will sit but rather creating and inhabiting contexts along the way, through juxtaposition. The frustration that this ricocheting recipe produces for some readers, like the Schwartz reviewer who wants to know "What forms of analysis become necessary when using 'similitude' as the basis of a scholarly argument?"[121] rests on a fear that similitude cannot properly be a *basis* of argument because it is too slippery, too subjective. But whence this anxiety?

In *Error and the Academic Self,* Seth Lerer argues that academic worry about mistakes, about error, is closely connected to apprehension about the *errant,* the nomadic. Containing, fixing, erasing errors has become the province of such disciplinary formations as the philology of J.R.R. Tolkien, which seeks to fasten traditions to firm foundations such as national linguistic genealogy or scientific accounts of the rational genesis or evolution of words. Meanwhile, the finding of sustenance in *slippage*—indeed, in troping—has often been the province of the exile, the émigré, and the estranged. Thus, Irish poet Seamus Heaney arrives at a kind of postcolonial translation of *Beowulf* through a fascination with the lateral transfection, rather than vertical transmission, of words into and out of Anglo-Saxon. Lerer also detects an attachment to errancy in the rhetorical philology of de Man, which etymologizes the names of tropes—in effect using the tools of philology to at first anchor and then unmoor the literal meanings of rhetorical devices—in order to demonstrate that language is figurative all the way down. Lerer suggests that such fascination "with estrangement and displacement" and "the wandering of meanings" has become the hallmark of rhetorical philology in America, "a landscape rife with being lost," so that, "to read as an American is to make tropes of words and, in the process, to replay in linguistic terms the patterns of emigration and estrangement that have made us who we are."[122] Schwartz's strategy in "De-Signing" is certainly to turn words into tropes, to unfasten words from etymology toward new rhetorical energies. On this view, Schwartz might be a scholar situated in Lerer's reading of the errant American. But turning to Schwartz's farewell book review for the *Journal of Unconventional History,* in which he calls for "histories written with a sense of our own human nonsensicalness,"[123] we as easily could detect a demand not just for troping but also for tripping over ourselves.

The more important question for me, however, is how Schwartz's work aids in understanding and uncovering the exuberance of such scientific enterprises as astrobiology, which chase after such overflowing objects as "life." Rather than

following a genealogical or archaeological model, Schwartz's methods of association suggest a fluid dynamics that follows flows of history into eddies that swirl both backward and forward in time and that operate at a variety of scales.[124] The recirculating temporalities that Schwartz offers complicate such science studies formulations as Andrew Pickering's "mangle of practice,"[125] which assume that historical accountings must cleave rigorously to a physical ontology of unidirectional time. Schwartz's analysis, animated by poetic linguistic play, can be brought into conversation with the refusal of science studies to rush to distinguish content and context, a strategy Joseph Rouse connected to a particular view of language in the inaugural issue of *Configurations,* the journal of the Society for Literature and Science: "There is no determinate scheme or context that can fix the content of utterances, and hence no way to get outside of language."[126] Schwartz's system of setting up discursive diffraction patterns rather than unified force fields of theory might be used as a tactic for writing a cultural studies of science attentive to the contingent conversations, conversions, and inversions that fashion the edges of the scientific lifeworld—fashionings that, because of their locatedness in a world of signification, often force scientists and theorists of science back on linguistic connections not entirely under their control. Schwartz's focus on language accents the complex pleasures and anxieties that animate the most technical research.

Schwartz's similitudes are thus trippier than the traffic written of by Evelyn Fox Keller and Elisabeth Lloyd in *Keywords in Evolutionary Biology:*

> By virtue of their dependence on ordinary language counterparts, technical terms carry, along with their ties to the natural world of inanimate and animate objects, indissoluble ties to the social world of ordinary speakers. . . . [They] have insidious ways of traversing the boundaries of particular theories, of historical periods, and of disciplines. . . . They serve as conduits for unacknowledged, unbidden, and often unwelcome traffic between worlds.[127]

Schwartz's approach does not highlight the insidious. By undertaking histories of configurations axial to but also at the edges of our cultural consciousness—copying, noise—Schwartz tracks a variety of motions, including tracing analogies that are sometimes out of bounds of a general articulated cultural experience or, more important, outside of disciplinary strategies for making sense. This makes it less interdisciplinary than *adisciplinary* or, if that's too evasively de-signing, *undisciplinary*—which is not to say undisciplined. Schwartz's extensive historical research, comprehensively condensed in his thorough cultural chronicles and also documented at high resolution in his detailed endnotes, is exhaustive,

encyclopedic, and exemplary in its curiosity and care.

How else can we place this approach? In addition to Lerer's provocative claim about the errant, we might also detect resonances with critiques of reflexivity in the social sciences, with those attempts to move away from reinscribing an already known social order in situating the cultural address of one's own theorization. In anthropology, Bill Maurer offers (rhyming with de Bono's sideways thinking and Lerer's attention to error) what he calls "Lateral Reasons for a Post-Reflexive Anthropology," arguing that

> If, after all, anthropology is not a quest for an accurate description of a social reality, but a "scale model of all the mistakes to be made in figuring it out," and if those mistakes are already anticipated by the social reality "under" investigation, . . . Anthropology would then be a practice of lateral reading and writing, neither descriptive nor explanatory but multiplicative.[128]

An anthropology of astrobiology (which remains to be done) would dig deeper into the shared motives, mistakes, and meanings in representing social life and searching for extraterrestrial life. Such an analysis would be alien to discipline.

But aliens, as astrobiologists can tell us, are good to think with. About life. About difference. About polar opposites. About doubles and imperfect twins. Insofar as this essay is about both astrobiology and Schwartz's method, it is an attempt to see what happens when different inscription tactics, different scholarly worlds, collide. I have sought to double astrobiology's similitude-seeking strategies by drawing upon Schwartz's, hoping in the process to generate connections that might be followed up empirically, theoretically, poetically, politically, by people in cultural studies of science and also by astrobiologists curious about how their practice looks from a world perhaps not so different from their own. At century's turn, doubles of earthly life abound and rebound off the face of Mars and the glare of Europa, signals of the noisy nuisance of this thing we call vitality. As Schwartz suggests, "At the ends of centuries, when fatefulness is widely at stake, Doubles rise to the occasion."[129] The Janus face of astrobiology, looking backward, looking forward, looking far away and close up, is a token of millennial preoccupations with self-reflection and the limits of our lively designs.

Notes

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1. Hillel Schwartz, *Century's End: A Cultural History of the Fin de Siècle from the 990s through the 1990s* (New York: Doubleday, 1990).

2. D.S. McKay, E.K. Gibson Jr., et al., "Search for Past Life on Mars: Possible Relic Biogenic Activity in Martian Meteorite ALH84001," *Science* 273 (1996): 924–930.

3. *Astrobiology* 1, no. 1 (2001).

4. P.J. Boston et al., "Cave Biosignature Suites: Microbes, Minerals, and Mars," *Astrobiology* 1, no. 1 (2001): 25–56.

5. For further work on Mars, microbes, and the poles, see B.M. Jakosky et al., "Subfreezing Activity of Microorganisms and the Potential Habitability of Mars' Polar Regions," *Astrobiology* 3, no. 2 (2003): 343–350. To be sure, scientists have been looking for microbes on Mars since the *Viking* voyages of the 1970s. See Norman H. Horowitz, "The Search for Life on Mars," *Scientific American* 287 (1977): 57–58.

6. S. Kempe and J. Kazmierczak, "Biogenesis and Early Life on Earth and Europa: Favored by an Alkaline Ocean?" *Astrobiology* 2, no. 1 (2002): 123–130. See also R. Cavicchioli, "Extremophiles and the Search for Extraterrestrial Life," *Astrobiology* 2, no. 3 (2002): 281–292. Europa has been a favorite site for science fiction speculation about extraterrestrial life, notably in Arthur C. Clarke's *2010*.

7. See Steven Dick, *The Biological Universe: The Twentieth-Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge, UK: Cambridge University Press, 1996); and B.S. Blumberg, "The NASA Astrobiology Institute: Early History and Organization," *Astrobiology* 2, no. 3 (2003): 464. On the early history of exobiology, see Audra J. Wolfe. "Germs in Space: Joshua Lederberg, Exobiology, and the Public Imagination, 1958–1964," *Isis* 93 (2002): 183–205; and Steven J. Dick and James E. Strick, *The Living Universe: NASA and the Development of Astrobiology* (New Brunswick, NJ: Rutgers University Press, 2004).

8. Monica Grady, *Astrobiology* (Washington, DC: Smithsonian), 81.

9. D.J. Des Marais, M.O. Harwit, et al., "Remote Sensing of Planetary Properties and Biosignatures on Extrasolar Terrestrial Planets," *Astrobiology* 2, no. 2 (2002): 153–181.

10. D.S. McKay, S. Clemett, et al., "Recognizing and Interpreting Biosignatures, Abstract #12873 (Oral Presentation)—The Classification of Biosignatures," *Astrobiology* 2, no. 4 (2002): 625.

11. Des Marais, Harwitt et al., 154.

12. McKay, Clemett et al., 625.

13. Hillel Schwartz, *The Culture of the Copy: Striking Likenesses, Unreasonable Facsimiles* (New York: Zone, 1996).

14. Hillel Schwartz, "De-Signing," *Critical Quarterly* 43, no. 2 (2001): 55–65.

15. Another recent discussion of the uses of Schwartz's copying work can be found in a 2002 issue of *Cultural Analysis* (3) on Copies/Reproduction/Seriality, http://ist-socrates.berkeley.edu/~caforum/volume3/vol3_toc.html (accessed 5 February 2004).

16. Schwartz, *Culture of the Copy,* 17.

17. Karen N. Werner, review of *The Culture of the Copy,* by Hillel Schwartz, *Social Problems Forum: The SSSP Newsletter,* 29, no. 2 (Summer 1997), http://www.sssp1.org/index.cfm/m/148/pageid/225 (accessed 9 January 2006).

18. Schwartz, "De-Signing," 55.

19. See Sarah Franklin, "Life Itself" (paper prepared for the "Detraditionalisation" Conference, Centre for Cultural Values, Lancaster University, Lancaster, England, 3 June 1993).

20. Damien Neva, "Finding Terrestrial Intelligence in the Search for Extraterrestrial Intelligence" (unpublished paper, New York University, 2001). A vast literature by SETI advocates seeks carefully to parse the philosophical and technological issues at stake here; see Carl Sagan, *The Demon-Haunted World: Science as a Candle in the Dark* (New York: Ballantine Books, 1997).

21. Hillel Schwartz, "The Indefensible Ear," in *The Auditory Culture Reader,* ed. Michael Bull and Les Back, 487–501 (Oxford, UK: Berg, 2003), 489.

22. Hillel Schwartz, "Noise and Silence: The Soundscape of Spirituality" (paper presented at the Inter-Religious Federation for World Peace "Realizing the Ideal: The Responsibility of the World's Religions" seminar, section IV: "Religion and the Ideal Environment," Seoul, 20–27 August 1995), http://www.nonoise.org/library/noisesil/noisesil.htm.

23. Dick, 401.

24. Dick, 440.

25. Dick, 440.

26. Dick, 440.

27. The idea that the orbits of the planets generate a "music of the spheres" was articulated by Kepler, who, building on Pythagoras in 1619, postulated that the planets' distances from the sun corresponded to musical intervals, thereby disclosing a divine harmony. Like Kepler, Oliver and Billingham imagine correspondence between worlds as a matter of calibrating to the proper scale.

28. Douglas Kahn, *Noise, Water, Meat: A History of Sound in the Arts* (Cambridge: MIT Press, 1999), 276.

29. Sebastian von Hoerner, "Universal Music?" *Psychology of Music* 2, no. 2 (1974): 18–28.

30. NASA Jet Propulsion Laboratory, "Mars Exploration Rover Mission: Science: Goals," http://marsrovers.jpl.nasa.gov/science/goals.html; and NASA, "Mars Exploration: Science: Goal 1: Determine If Life Ever Arose on Mars," http://marsprogram.jpl.nasa.gov/science/life/index.html.

31. Des Marais, Harwitt et al., 156.

32. Grady, 82.

33. For foundational thinking about the mathematics of chirality and of various kinds of symmetry more broadly, see Hermann Weyl, *Symmetry* (Princeton: Princeton University Press, 1952). On the chemistry of life, see Bruce Jakosky's *The Search for Life on Other Planets* (Cambridge, UK: Cambridge University Press, 1998).

34. Des Marais, Harwitt et al., 154.

35. Des Marais, Harwitt et al., 153.

36. Grady, 82–83.

37. McKay, Clemett et al., 625; emphasis in original.

38. McKay, Clemett et al., 625; emphasis in original.

39. Richard Doyle, *On Beyond Living: Rhetorical Transformations of the Life Sciences* (Stanford: Stanford University Press, 1997), 45.

40. See Charles Sanders Peirce, *Collected Papers of Charles Sanders Peirce, Volumes 1–6,* ed. Charles Hartshorne and Paul Weiss, *Volumes 7–8,* ed. Arthur Burks (Cambridge: Harvard University, 1931–1935, 1958).

41. Schwartz, *Culture of the Copy,* 219.

42. Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences*, trans. Alan Sheridan (New York: Random House, 1970).

43. See Marjorie Garber, *Quotation Marks* (New York: Routledge, 2003) for more on the multiple uses of these devices.

44. Thanks to Hillel Schwartz for this phrasing.

45. Jacques Derrida, "Signature Event Context," in *Margins of Philosophy,* trans. Alan Bass (Chicago: University of Chicago Press, 1982), 328.

46. D.J. Des Marais, L.J. Allamandola et al., "The NASA Astrobiology Roadmap," *Astrobiology* 3, no. 2 (2003): 233.

47. David Eggers, *You Shall Know Our Velocity!* (New York: Vintage Books, 2003), 184.

48. Richard Doyle, *Wetwares: Experiments in Postvital Living* (Minneapolis: University of Minnesota Press, 2003), 196. For a complementary discussion of how cellular life-as-we-know-it gathered animacy through filmic and computer-graphical animations, see Christopher Kelty and Hannah Landecker, "A Theory of Animation: Cells, L-systems, and Film," *Grey Room* 17 (2004): 30–63. Like biosignatures, animations fold representational strategies into the logic of life itself.

49. Blumberg, 467.

50. David Grinspoon, *Lonely Planets: The Natural Philosophy of Alien Life* (New York: Ecco, 2003), 35.

51. Blumberg, 470.

52. Doyle, *Wetwares,* 25.

53. http://marsprogram.jpl.nasa.gov/science/life/.

54. Des Marais, Allamandola et al., 234.

55. *Jeff Wayne's Musical Version of* The War of the Worlds (Columbia Records, 1978).

56. Indeed, Derrida and Schwartz intersect at only one point in *The Culture of the Copy:* Schwartz's entry for Derrida in his index reads "nary an appearance in the text." Schwartz, *Culture of the Copy,* 543. Derrida's presence is an absence.

57. The potential recognition that we earthlings are all aliens—from Mars, for example—generates now a positive excitement difficult to envision existing one hundred years ago, at least in the United States and Europe, when the possibility that "we" might be alien to ourselves—or might contain "alien ancestry"—often awoke fears about reversion and racial degeneration.

58. See Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," *Critical Inquiry* 21, no. 1 (1994): 228–266.

59. McKay, Clemett et al., 625.

60. Schwartz, "De-Signing," 55.

61. Schwartz, "De-Signing," 57.

62. Schwartz, "De-Signing," 63–64.

63. Foucault, xv.

64. Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge: MIT Press, 2000). On torque, see Hillel Schwartz, "Torque: The New Kinaesthetic of the Twentieth Century," in *Zone 6: Incorporations,* ed. Jonathan Crary and Sanford Kwinter, 70–126 (Ottawa, Canada: Bradbury Tamblyn and Boorne Ltd., distr. MIT Press, 1992). See also Stefan Helmreich, "Torquing Things Out: Race and Classification in Geoffrey Bowker and Susan Leigh Star's *Sorting Things Out: Classifications and Its Consequences*," *Science, Technology, and Human Values* 28, no. 3 (2003): 435–440.

65. Des Marais, Harwit et al., 157.

66. Peter Redfield, *Space in the Tropics: From Convicts to Rockets in French Guiana* (Berkeley: University of California Press, 2000).

67. See R.F. Knacke, "Possibilities for the Detection of Microbial Life on Extrasolar Planets," *Astrobiology* 3, no. 3 (2003): 537.

68. Des Marais, Harwit et al., 154.

69. See Doyle. On biochemical specificity and cryptography, see Lily Kay, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford: Stanford University Press, 2000).

70. NASA; emphasis added.

71. See Humberto Maturana and Francisco Varela, *Autopoiesis and Cognition: The Realization of the Living* (Dordrecht, Netherlands: Reidel, 1980). For a critique of autopoiesis that misses this point, see Slavoj Žižek, *Organs without Bodies: On Deleuze and Consequences* (New York: Routledge, 2004).

72. McKay, Gibson et al. See also A.H. Treiman, "Submicron Magnetite Grains and Carbon Compounds in Martian Meteorite ALH84001: Inorganic, Abiotic Formation by Shock and Thermal Metamorphism," *Astrobiology* 3, no. 2 (2003): 369–392.

73. A. Steele et al., "The Microbiological Contamination of Meteorites: A Null Hypothesis" (paper presented at the First Astrobiology Science Conference, NASA Ames Research Center, Ames, Iowa, 3–5 April 2000).

74. Robert Markley, *Dying Planet: Mars in Science and the Imagination* (Durham, NC: Duke University Press, 2005), 325.

75. See "Wittgenstein on Mars," http://www.georgecoates.org/OnMars/.

76. K.L. Thomas-Keprta et al., "Abstract #12641—Biogenic Magnetite Crystals in Martian Meteorite ALH84001," *Astrobiology* 2, no. 4 (2002): 606.

77. J. Toporski and A. Steele, "Abstract #12676—The Relevance of Bacterial Biomarkers in Astrobiological Research: Setting a Standard," *Astrobiology* 2, no. 4 (2002): 608.

78. S.L. Cady et al., "Morphological Biosignatures and the Search for Life on Mars," *Astrobiology* 3, no. 2 (2003): 352. The debate goes on, with some researchers supporting the biotic origin of ALH84001 with studies in biomineralization and others contesting biogenesis through work on non-biological crystal morphology. The detection of analogous shapes through an appeal to amplification has been crucially questioned as the royal road to reading signs of life in ALH84001.

79. Markley, 334.

80. Markley, 7. And see Markley for an excellent discussion of the analogical reasoning animating comparisons of Mars with Earth. Markley writes that "Because it works by *induction,* a point-by-point comparison of observed characteristics or phenomena, analogical thinking has the potential to call into question the very principles that allow such comparisons to be made" (8).

81. M.C. Malin and K.S. Edgett, "Evidence for Recent Ground Water Seepage and Surface Runoff on Mars," *Science* 288 (2000): 2325–2330. See also M.D. Max and S.M. Clifford, "Initiation of Martian Outflow Channels: Related to the Dissociation of Gas Hydrate?" *Geophysical Review Letters* 28 (2001): 1787–1790.

82. Schwartz, "De-Signing," 60.

83. Joseph Dumit, *Picturing Personhood: Brain Scans and Biomedical Identity* (Princeton: Princeton University Press, 2004), 102.

84. W. Charles Lamb, "Letter to Dr. Walter S. Adams, Mount Wilson Observatory in Pasadena, California, 7/26/28," in *No One May Ever Have the Same Knowledge Again* (Supplement to a Chain of Flowers Volume IV, Number 7, Guide Leaflet Number 5), ed. Sarah Simmons (West Covina, CA: Society for the Diffusion of Useful Information Press, 1993).

85. For a Creationist interpretation of the imbalance of right- and left-handed compounds in biotic nature, see Jonathan Sarfati, "Origin of Life: The Chirality Problem," *TJ* 12, no.3 (December 1998): 263–266, http://www.answersingenesis.org/tj/v12/i3/chirality.asp.

86. P.H. Figueredo et al., "Locating Potential Biosignatures on Europa from Surface Geology Observations," *Astrobiology* 3, no. 4 (2003): 852.

87. Figueredo et al., 856.

88. K. Khurana, M.G. Kivelson, and C. Russell, "Searching for Liquid Water in Europa by Using Surface Observatories," *Astrobiology* 2, no. 1 (2002): 93–103.

89. Hillel Schwartz, "Hearing Aids: Sweet Nothings, or an Ear for an Ear," in *The Gendered Object,* ed. Pat Kirkham, 43–59 (Manchester, UK: Manchester University Press, 1996).

90. J.B. Dalton et al., "Near-Infrared Detection of Potential Evidence for Microscopic Organisms on Europa," *Astrobiology* 3, no. 3 (2003): 505.

91. NASA Jet Propulsion Laboratory, "Calibration Targets," http://marsrovers.jpl.nasa.gov/mission/spacecraft_instru_calibr.html.

92. NASA Jet Propulsion Laboratory, "Revealing Mars' True Colors: Part Two" (28 January 2004), http://marsrovers.jpl.nasa.gov/spotlight/spirit/a13_20040128.html.

93. See Knacke, 537.

94. P.C.W. Davies, "Does Life's Rapid Appearance Imply a Martian Origin?" *Astrobiology* 3, no. 4

(2003): 675.

95. Davies, 674–675.

96. Davies, 678.

97. The spontaneity at play might look different from at least two of the examples Schwartz gives under this head: roller coasters and mobile phones, both of which are the result of dense networks of calculation, engineering, and labor. We might read Schwartz as indicating rather the experience of users—in which case such *spontaneity* depends on a *simplification* that erases the physical construction of such artifacts as Coney Island's *Cyclone* and Nokia's cell phones.

98. Grady, 82.

99. Grady, 91.

100. Schwartz, *Culture of the Copy* (above, n. 13), 351. The happy running companions many people believe dogs to be may have a paw in the appeal of Mars Rovers and *Beagles*.

101. BLUR.CO.UK, http://www.blur.co.uk/site.html.

102. See Doyle, *On Beyond Living;* and Stefan Helmreich, *Silicon Second Nature: Culturing Artificial Life in a Digital World,* rev. ed. (Berkeley and Los Angeles: University of California Press, 2000).

103. Doyle, *Wetwares,* 21.

104. Doyle, *Wetwares,* 20; emphasis in original.

105. Schwartz, "De-Signing," 63.

106. Michael Taussig, *Defacement: Public Secrecy and the Labor of the Negative* (Stanford: Stanford University Press, 1999).

107. Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987), 168.

108. Deleuze and Guattari, 172.

109. Deleuze and Guattari, 181.

110. Deleuze and Guattari, 190; emphasis in original.

111. Paul de Man, "Autobiography as Defacement," in *The Rhetoric of Romanticism* (New York: Columbia University Press, 1984), 81. Blumberg's "The NASA Astrobiology Institute" is alive to this doubleness. Writing of "the question 'What is life and how is it characterized?'" Blumberg offers that "allied with this is an understanding of death: 'When does life cease, and how can its effects be detected and measured in fossil remains and in the influences that life has on its environment that remain after the disappearance of the living material?'" Blumberg, 465.

112. De Man, 70.

113. A further discussion of defacement can be found in Bernadette Wegenstein's "Getting Under the Skin, or, How Faces Have Become Obsolete," *Configurations* 10 (2002): 221–259. Wegenstein argues that not only has faciality been dispersed across the skin—Deleuze and Guattari's argument—but the interiority for which it stands has been allowed to inhabit a plurality of organs: "It is not necessarily behind faces that we expect the person to be revealed. Faces are becoming obsolete. . . . In short, any body part has the potential to become this special 'window to the soul,'" at 233–234. We could say the same for "life" in astrobiology; it has migrated onto other planets.

114. Werner.

115. A lovely elaboration of this etymological connection can be found in James Hamilton-Paterson,

The Great Deep: The Sea and Its Thresholds (New York: Random House, 1992).

116. Putting things this way demands an accounting of the rhetoric of vision—a rhetoric, indeed, that suffuses Schwartz's genres of "de-signing." Further, however, I think it requires us to think about the sensory registers in which we pitch our metaphors, with which we think things through one another.

117. Steven Knapp and Walter Benn Michaels, "Against Theory," *Critical Inquiry* 8, no. 4 (1982): 723–742.

118. I ask, then, as Peter Galison puts it, that "theory arrive . . . in a more piecemeal way, with concepts as tools to disrupt texts, images, and experience." Peter Galison, "Specific Theory," *Critical Inquiry* 30, no. 4 (2004): 380.

119. Markley, 324.

120. See Doyle, *On Beyond Living,* 107.

121. Werner.

122. Seth Lerer, *Error and the Academic Self: The Scholarly Imagination, Medieval to Modern* (New York: Columbia University Press, 2003), 178.

123. Hillel Schwartz, "Toys, Poise, and Noise: A Review of *Kids' Stuff: Toys and the Changing World of American Childhood,* by Gary Cross, *Meetings, Manners and Civilization: The Development of Modern Meeting Behaviour,* by Wilbert van Vree, and *Noise, Water, Meat: A History of Sound in the Arts,*" *Journal of Unconventional History* 11, no. 2 (2000): 110.

124. For a discussion of the metaphor of fluid mechanics in the work of Bruno Latour, see T. Hugh Crawford, "Networking the (Non) Human: *Moby-Dick,* Matthew Fontaine Maury, and Bruno Latour," *Configurations* 5, no. 1 (1997): 1–21.

125. Andrew Pickering, "The Mangle of Practice: Agency and Emergence in the Sociology of Science," *American Journal of Sociology* 99, no. 3 (1993): 559–589.

126. Joseph Rouse, "What Are Cultural Studies of Scientific Knowledge?" *Configurations* 1, no. 1 (1993): 74.

127. Evelyn Fox Keller and Elisabeth A. Lloyd, "Introduction," in *Keywords in Evolutionary Biology,* ed. Evelyn Fox Keller and Elisabeth A. Lloyd (Cambridge: Harvard University Press, 1992), 1–2.

128. Bill Maurer, *Mutual Life, Limited* (Princeton: Princeton University Press, 2005), 7. On the matter of modeling mistakes, Maurer quotes here from Roy Wagner, *An Anthropology of the Subject* (Berkeley: University of California Press, 2001), xiii.

129. Schwartz, *Century's End,* 212.