Makeover: Writing the Body into the Posthuman Technoscape
Part Two: Corporeal Axiomatics

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The essays in Part 1 of this *Configurations* special issue urged that the posthuman is getting under our skin, and they offered ways of resisting interpretations of a posthuman future that depend on the notion that information is disembodied. Our discussions have attended to the distinction between practices of inscription and practices of incorporation. By "inscription practices" we mean the range of discourses and rhetorics of persuasion from computer science, biotechnology, robotics and nanotech, media studies, art, film, video games, science fiction, literary studies, philosophy, and advertising—all the things we say and write, the representations we construct; in short, the codes we circulate about information and its relation to bodies. By "practices of incorporation" we mean the norms, behaviors, skills, and schemas of physical enaction that modulate the embodiment of these culturally constructed inscriptions and the performances of actual bodies—insofar as it is possible—in terms of them. In this dynamic of material/semiotic agents, resistances of material bodies produce fissures in the various strata; feedback between these processes generates new lines of flight.

But how literally are we to understand the processes of inscription? Discussions of hybrid human-machine interactions have tended to see the material, machinic components on the other side of the cyborg interface as "enhancements," extensions, or reconfigurations of the senses; the machine extends anthropomorphically, rather than fundamentally remaking the human. By contrast, the recent developments in cellular robotics that we described may

Configurations, 2002, 10:373–385 © 2004 by The Johns Hopkins University Press and the Society for Literature and Science.

suggest a more direct interpretation of inscription, where protein logic circuits are built into cellular machinery in order to engineer molecular design and assembly. Even so, human engineers and programmers will presumably continue to design the logic circuits and write the programs. More critical for the essays included here is the point that even though these processes are materially inscribed, logic assimilates them to language and discourse. Everywhere we look, nature—even machinic nature—always seems to have a human face.

This tension between the discursive and the material, and ways to think about the interface between inscriptional and incorporational practices—the capillary anastomosis suturing the material/semiotic agents of recent science studies work—form the subject of the essays in Part 2 of this special issue. The dilemma over the direction to be taken in addressing these issues is brought out in the mutually appreciative exchanges by Katherine Hayles and Mark Hansen in their recent works.[1] In *How We Became Posthuman* and in her essay in this volume, Hayles urges that in order to prevent the takeover of our posthuman future inspired by a technologically deterministic notion of information as disembodied, we must reshape discourse in ways that foreground embodiment. As her paper in this volume illustrates, for Hayles's initiative it is important to call attention to the ways in which language emerges from bodily and physical realities murmuring to the "mind-brain." As allies in this effort she draws on the work of cognitive scientists and psychologists such as Antonio Damasio, Andy Clark, and Edwin Hutchins, and philosophers George Lakoff and Mark Johnson, who argue for an "extended mind" model of cognition embedded in the world—a model in particular that dissolves boundaries between technical objects and the preconscious domains of cognition, and affirms the importance of emotion, proprioception, kinesthesia, and other sensations in cognition.

A second, related approach that Hayles develops is the deconstruction of the established discursive regimes surrounding our notions of information. The most salient example is her analysis, in *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*, of how information lost its body in the debates among the members of the early cybernetics movement at the annual Macy Conferences held from 1943 to 1954. She argues that the Shannon-Weaver theory, which set the agenda of those meetings, views information stochastically or probabilistically. The central notion of information in Claude Shannon and Warren Weaver's work

1. See esp. N. Katherine Hayles, "Foreword: Clearing the Ground," in Mark Hansen, *Embodying Technesis: Technology Beyond Writing* (Ann Arbor: University of Michigan Press, 2000), pp. v–ix.

is that the information carried by a message or symbol depends on its probability of being selected. It is carried discretely as symbols encoded as binary digits, which are selected from a set of possible symbols. For Shannon, the issue was not about communicating significance or meaning, but simply about optimizing the signal-to-noise ratio in message transmission. Shannon measured information as inversely proportional to the probability of a signal reaching its receiver, and its quality in this formulation is determined by message length, complexity, and signal integrity. The *meaning* of the symbols encoding a message is completely irrelevant, though a binary digit may represent the toss of a coin (heads or tails) or the fate of the universe (expand or collapse). Hayles makes the valuable point that Shannon and Weaver sought a general formulation of information that could be calculated as the same value regardless of the contexts in which it was embedded. Conceived in this way information was a probability function with no dimensions, lacking materiality, and without necessary connection with meaning.[2]

In contrast to this notion of information as completely decontextualized and separate from meaning, the British researcher Donald McKay was developing an alternative approach that included recognizing not only the probability of selecting a message as its informational value, but also a structural component of a message that indicates how it is to be interpreted. Structural information in McKay's view is semantic, and has to be calculated through changes brought about in the receiver's mind. This view of information strongly correlates the nature of a representation and its effect, making information an action measured by the effect it has in the receiver. Put simply, whereas the Shannon-Weaver model treats what information *is*, the McKay model measures information by what it *does*. This mutual constitution of message and receiver seemed too subjective and difficult to measure and so was dropped by the American cyberneticists, even though it continued to be central for the British school of information theory. Hayles's point here, and its relation to our problem, is that alternative models of information were available. The path taken was not inevitable, and the (Shannon-Weaver) version that was accepted was due to historical contingencies related to the strength of allies and the availability of quantitative techniques associated with the Shannon model. An alternative discourse could have been constructed.

For Hayles, there is no getting outside of discourse. While we may want to recognize technology or material agency as things in them-

2. N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999), p. 52.

selves outside of discourse, what matters are the interfaces that embed technology in human culture and the (discursive) moves made to erase these processes of inscription. The contrast with the approach that Mark Hansen advocates could not be stronger. Whereas for Hayles the key point is how technology is brought into discourse and what opportunities there are for redirecting that discourse, Hansen has pressed for a radical break with representationalism, and indeed with the linguistic model altogether. He simply cuts the Gordian problematic of how inscription relates to incorporation, and similarly the relation of theory to practice and of representations to material agency.

For more than a decade science studies has sought accounts of how theoretical representations of nature are constructed and attached to the world. Some of us looked to poststructuralist approaches that took up issues of the technologies of representation, inscription, and the material aspects of communication—frameworks deriving from literary and media scholars such as Derrida and Friedrich Kittler. Closely allied with such approaches have been laboratory-intensive accounts such as Hans-Jörg Rheinberger's treatment of "epistemic things," while others explored sociologically inspired models of the "mangle of practice" and "trading zones," or the construction of "epistemic cultures." As Hansen has shown brilliantly, there was a deep-seated ambivalence about material agency in these studies. On the one hand we wanted to grant practice, and indeed even technology, a materiality of its own—Bruno Latour has even advocated a Parliament of Things—but on the other hand, nature and technology in these accounts is always somehow "humanized" as a social/cultural construction. Hansen's first book, *Embodying Technesis: Technology Beyond Writing*, and his rich elaboration and extension of the model proposed there in his recent book, *Framing the Digital Image,* criticize theorists from the fields of poststructuralist theory and cultural studies for having stopped short of embracing the truly radical aspects of their critical stance toward representationalism. According to Hansen, Derrida, Bourdieu, Baudrillard, and others have all been engaged in a common pattern of reduction—Hansen calls it *technesis*—in which a stated interest in embracing technological materiality is compromised in order to safeguard the integrity and autonomy of thought and representation. He shows that this strategy functions by collapsing radical material exteriority into a merely relative exteriority paradoxically situated *within* the domain of thought.

Hansen's aim is to offer a positive program for embracing the rich materiality of technology that frees it from being embedded in dis-

course and representation. The position he stakes out draws deeply upon Henri Bergson's defense of the affective, prediscursive body as the active source of meaning. Hansen finds empirical support for this Bergsonist program and its relevance to our current concerns over posthumanism and digitality in the work of cognitive scientists such as Varela, Hutchins, Clark, Damasio, and others who have defended the notion of the extended mind—the very same work, in fact, that Hayles draws upon in her paper in Part 1 of this volume. From Hansen's perspective, technologies alter the very basis of our sensory experience and drastically affect what it means to live as *embodied* human agents. They accomplish this by reconfiguring the senses at a precognitional or even paracognitional level (not to privilege one level over the other), prior to conscious perception and assimilation to language.

This very bold and ambitious program was only sketched in *Embodying Technesis*. *Framing the Digital Image* carries that program further by offering an account of how the body is modified through interactions facilitated by technology. Starting from a critique of Gilles Deleuze's classic work on film, Hansen argues that the technical features of digital image-processing are leading to a replacement of the time-image and film-image as described by Deleuze. In their place a new image regime, the digital-image, is emerging. Critical of Deleuze's treatment of the film-image in which the cinematic image was purified of connection with the human body, Hansen argues that every image regime, including the digital, is primarily enframed by an "embryogenic" connection with the human body. In contrast to Deleuze's arguments on technical framing as the source of the image which is then correlated to the body, Hansen resuscitates Bergson's notion of the primary framing function of the body. According to this "Bergsonist imperative," there is no information (or image) in the absence of the form-giving potential of human embodiment. In order to update Bergson's pre–Information Age perspective, Hansen draws on the work of Raymond Ruyer, an overlooked French information theorist who shared and extended Donald McKay's critique of the Shannon-Weaver notion of information by arguing that information requires a frame in order to be constituted as information, and that the frame is provided by the active constitution and assembly of human embodiment.[3] Following this line of argument, "machinic vision," the turn of phrase in recent work where computers are claimed to process data into images that are then sent to other computers to be read, is something of an oxymoron. This can only

3. Raymond Ruyer, *La cybernétique et l'origine de l'information* (Paris: Flammarion, 1968).

be "vision" by analogy, in Hansen's view. Vision, as do all systems involving "information," requires an interpreter, and that interpreter is the material human body grounded in the wetware of our sensorimotor systems.

Hansen's defense of a Bergson-inspired approach to media requires an expansion, and indeed inversion, of the hierarchy of the senses that has occupied art-historical discourse on digital media since the work of Jonathan Crary. Crary and many other theorists who have followed his lead have argued that new digital media are relocating vision to a plane severed from a human observer, while traditional functions of human vision are being supplanted by new media practices in which visual images no longer refer to the position of an observer in a "real," optically perceived world. Hansen takes issue with this view and argues for displacing an abstracted sense of vision as the primary sense in favor of the internal bodily senses of touch and self-movement. Vision becomes "haptic" in Hansen's effort to relocate visual sense-making in the body. Hansen's discussion of Diller + Scofidio's Blur Building and his treatment of wearable space in Part 1 of this volume provides a concrete illustration of this Bergsonist perspective in relation to digital media. He argues for the primacy of affective and interoceptive sensory processes that generate a "haptic spatiality," an internally grounded image of the body prior to and independent of external geometrical space. This view has a range of interesting consequences for the interpretation of other new media. For instance, Virtual Reality in Hansen's view is not the simple product of technical advances in computer graphics. It is not only the ability to process more polygons and run hierarchies of shading algorithms faster that creates the Virtual Reality experience; rather, that experience is grounded in the biological potential of human beings. Virtual Reality is, Hansen argues, a body-brain achievement. The source of the virtual is thus not technological, but rather a biologically grounded adaptation to newly acquired technological extensions provided by new media.

The papers in this volume are in critical dialogue with the positions on technology, language, and embodiment that have engaged Hayles and Hansen. Casey Alt's paper speaks directly to the problem of the digital interface and the supposed immateriality of computer-generated media. As someone immersed in computer-design work, Alt rejects the position popularized by Jean Baudrillard, Jonathan Crary, and Friedrich Kittler that digital media such as computer modeling, computer graphics, and Virtual Reality relocate vision to a plane severed from the human observer. To ground his critique, Alt focuses on the design environment of Maya, a premier group of ad-

vanced 3-D modeling programs used by architects, video-game artists, film animators, creators of special effects, and designers in an increasing number of other fields. He explores the material affordances and constraints of the machine interface and the sense of physical space and material logic that emerges for artists who have learned to work within the medium. In a brilliant tour of the workings of Maya, Alt argues that artists using Maya must

> gradually learn to *think Maya* and *move through Maya* just as a modern endoscopic surgeon must learn to successfully manipulate and navigate current media technologies in performing each surgery. . . . In order to successfully use Maya, users must crawl inside, navigate, and inhabit the logic of the application's complex interactive space. To do so, they must gradually adapt their usual habits of interaction to accommodate Maya's unconventional interface—a process that effectively reorganizes perception and cognition into a new field of relations.

This reorganization of perception is the effect of an intricate human-computer coevolution of design requirements and interface enabled by Maya's own unique object-oriented programming language. Alt argues that Maya's interface and object-oriented design environment represent data objects as a world of haptic, 3-D nodes, where each of the nodes is itself a computer simulation. Maya's objects have a directly embodied presence as visual and haptic 3-D objects that can be manipulated and interconnected within a perceivable space. Rather than implementing the top-down design strategy typical of procedural programming methods, scenes emerge within Maya's object-oriented programming environment through the literal *building* of various scene objects and the enabling of interactions between those objects in order to produce the object's desired final behavior.

In a manner similar to Mark Hansen's paper in these volumes, Alt's essay reaffirms the embodied, literally tactile quality of these computer-generated environments. The world of Maya is, in effect, a computer implementation of a Leibnizian monadology, where space is organized in terms of local, object-to-object contact and interaction rather than in terms of a global, singly unified perspective—the distinction best captured by Deleuze and Guattari's notion of haptic as distinguished from optic space. While an observer can occupy the perspective of only one of many distinct and heterogeneous objects *inside* or *on* a haptic space, observers in an optic space always occupy a distant and externally fixed perspective that exists as an ideal extension of homogeneous space. Like Hansen, Alt argues that space and vision become haptic, and, in another point of resonance with Hansen's and Hayles's insistence on the affective body as

the source of meaning in digital environments, he concludes that Maya's "haptic" spaces should be considered *affective spaces* because changes in the emergent space of organization are reflected by *internal state changes* (*affects*) within the various elements of the distributed field of objects. Nothing *external* to the elements ever changes; all the changes occur *within* the separately encapsulated objects.

Brian Rotman is also interested in the issue of digital technology's materiality and its engagement with the body on a preinstrumental, prediscursive, presemiotic level of unmediated physicality. In his paper for this volume Rotman asks whether alphabetic inscription is not rapidly becoming archaic, soon perhaps to become obsolete in our posthuman future; he wonders whether other tools might replace alphabetic inscription as the principal cognitive tool and medium. Here he specifically proposes motion capture as a nonnotational medium which might provide the basis for what he describes as a new grammaticalized "gesturology" beyond writing and speech, based on recording the body's gestural activities and organs of grasping and touch. Rotman asks: "Could bringing (a digitally objectified) gesture out from under the shadow of the spoken word install a new order of body mediation?" Such a move, he argues, could extend to a rethinking of the status of human corporeality.

Like Rotman, Sha Xin Wei also examines notions of embodiment and materiality in light of our increasing saturation in digital media, and he is intent on finding ways of investigating them that avoid their reduction to categories of information, semiotics, and cybernetics. Despite having articulated the importance of investigating the prediscursive body, particularly the domain of affect, gesture, and its connection to technology—what Rotman calls technology's corporeal axiomatic—Xin Wei argues that neither Hayles, Hansen, nor Rotman himself has gone far enough in extricating materiality and agency from linguistic models. His paper in this volume outlines both a theoretical argument and an experimental system—what Xin Wei calls a responsive media space—for investigating gesture and agency as embodied, alinguistic experience.

The field Xin Wei is exploring here was described by Deleuze and Guattari as asignifying semiotics, a field that Guattari hoped would liberate us from oppressive medialization and lead to a "post-media era characterized by the reappropriation and resingularisation of the use of media."[4] Guattari discussed asignifying semiotic machines in outlining the components of subject formation, which he took to be threefold:

4. Félix Guattari, *Chaosmosis*: *An Ethico-aesthetic Paradigm* (Bloomington: Indiana University Press, 1995), p. 5.

> 1. Signifying semiological components which appear in the family, education, the environment, religion, art, sport. . . . 2. Elements constructed by the media industry, the cinema, etc. 3. A-signifying semiological dimensions that trigger informational sign machines, and that function in parallel or independently of the fact that they produce and convey significations and denotations, and thus escape from strictly linguistic axiomatics.[5]

Guattari notes that structuralists have not given autonomy to this asignifying regime, and although some, such as Derrida, have shed light on the relative autonomy of this sort of component, they have in general reduced it to the linguistic, significational economy of language. Guattari insists there is another stratum in "the enunciative substance" in which machinic processes work below or outside the level of meaning:

> a-signifying semiotics which . . . handle figures of expression that might be qualified as "non-human" (such as equations and plans which enunciate the machine and make it act in a diagrammatic capacity on technical and experimental apparatuses.) . . . Structuralists have been content to erect the Signifier as a category unifying all expressive economies: language, the icon, gesture, urbanism or the cinema, etc. They have postulated a general signifying translatability for all forms of discursivity. But in so doing, have they not misunderstood the essential dimension of machinic autopoiesis?[6]

Xin Wei's goal in this essay (and in the larger project of which it is part) is to develop ways of exploring this domain, which he metaphorizes as magmatic, in which signs as things and things as signs evolve without, or perhaps prior to, meaning as language. He wants to consider gesture without appeal to any mental process or to cognition as a prior phenomenon. In order to do this he constructs an experimental apparatus for aesthetics which in fact materializes Guattari's asignifying machine. He calls the system the TGarden: "A TGarden is a responsive media environment, a room in which people can shape projected sound and video as they move." Using digital video and sound, a TGarden materializes gesture in the interplay of physical movement and computationally mediated response.

> Upon entering a TGarden space, each visitor—called a player—is asked to choose a costume from a set of garments designed to estrange the body from its habitual movement and identity. An assistant dresses the player, strapping wireless sensors on the player's chest and arm. The player is then led into a dark space illuminated only by video projected from . . . above onto the floor, a space filled with sound already in a residual motion. . . . As the player moves, her ges-

5. Ibid., p. 4.

6. Ibid., p. 37.

> tures and movement across the floor perturb the field of sound, modifying existing sound and introducing new patterns. The room's own autonomous processes generate a musical "cantus firmus," and each player effectively carries into the room another voice, but one that is semiautonomous, parameterized by gesture and by the state of the software system. [The gestures are mapped to video and sound via a continuous, dense dynamical system.] The synthesized video projected onto the floor provides a visual topography for the player to navigate. In some instances, objects appear projected onto the floor, but always transforming semiautonomously according to the movements of the players.[7]

The TGarden, therefore, is an environment that provides glimpses of what things, what substances and what *subjects,* can be shaped by and made palpable by gestures. The claim is that such responsive media spaces, both in their construction and in the experiences that they sustain, call into question linguistic and informatic models of gesture and open new ways to understand gesture and agency as embodied, alinguistic experience.

Xin Wei's paper and his TGarden system for experimental aesthetics are not only fascinating in their scope and imagination; his effort to construct an emergent computational system that instantiates an asignifying semiotic machine should also provide ample ground for reflection on our primary object of investigation here: namely, the posthuman and its relationship to the machinic. This volume's concluding paper by John Johnston brings us back to this site with a sobering look at the intertwined histories of computation, cognitive science, and artificial life, and at their current trajectory. As I have noted throughout these pages of introduction, the authors in these volumes fully embrace our presumed posthuman future (or present, since according to Hayles, we are already—or have always been—posthuman). A central point of agreement among most of these authors is captured by Mark Hansen's effort to reclaim meaning and information for the human by calling attention to the inescapable role of embodiment in the framing of information, just as Brian Rotman has in several books and essays called attention to the inescapable role of embodiment in computation.[8] Johnston is less sentimental about preserving space for the human.

7. As Xin Wei explains, the TG2001 sound- and visual-synthesis software he has written contains multiple processes that work in parallel. Even in the absence of any input from the player's movement, these processes synthesize and evolve textures according to a predesigned pseudo-physics. The player's movements are mapped via statistical filters to continuously varying parameters that hint or perturb the evolution of the video and sound synthesis processes. In this sense these processes are semiautonomous.

8. See esp. Brian Rotman, *Signifying Nothing: The Semiotics of Zero* (Stanford: Stanford University Press, 1993 [reprint]); idem, *Ad Infinitum—The Ghost in Turing's Machine: Tak-*

Johnston's essay opens with a magisterial overview of the theory of technics from the works of Deleuze and Guattari, Jacques Lacan, Gilbert Simondon, and Bernhard Stiegler. The key points that he draws from their works are that human knowledge is technological in its essence, that there are no possibilities of knowledge without the surfaces of inscription of an artificial memory, and that the concrete characteristics of these supports as organized inorganic matter constitute the reality of human cognitive operations. These points are all central, of course, to recent developments in cognitive science and the computational disciplines. It is not just that humans and machines have coevolved, and that our technics are prostheses. For Johnston, the take-home lesson from recent work emphasizing that computation is fundamental to nature is that "prosthesis" is originary and not a supplementary extension or add-on; computation must be part of this primordial constitution of the "who and the what." He argues that among the early French poststructuralists only Jacques Lacan entertained the possibility that "computation as a process may be part of 'poiesis,' both in nature and in its artificial simulations"; and as a consequence of his encounter with early cybernetics, Lacan came to believe that

> the symbolic order can provide a basis for social organization precisely because it is a form of autonomous computation. A simple information-processing machine "in-mixed" in human behavior, the symbolic order arises from counting practices and the emergence of self-organizing "laws" in primitive notation systems. . . . For Lacan, cybernetics and the new digital information machines make these laws visible in and for themselves, and thus establish the truism that the "world of the symbolic is the world of the machine." . . . the symbolic order is not language but an abstract machine that takes the exchanges that occur within language as its support.

While the poststructuralist thinkers considered by Johnston did not for the most part appreciate the importance of computation in technics, he argues that discussions such as Stiegler's treatment of the dynamics of technical systems provide valuable resources for theorizing the advent of machinic self-organization and self-reproduction in cybernetics and Artificial Life, the cornerstones of our future posthuman life. Among the notions most relevant to our present concerns is the idea that models of biological evolution could also be applied to the evolution of the "technical system." Deleuze and Guattari, Johnson explains, have best captured this with their notions of "assemblage" and the "machinic phylum"—a realm where

ing God Out of Mathematics and Putting the Body Back In: An Essay in Corporeal Semiotics (Stanford: Stanford University Press, 1993).

matter (including inorganic matter) is active and exhibits "materiality, natural or artificial, and both simultaneously; it is matter in movement, in flux, in variation, matter as a conveyor of singularities and traits of expression."[9] As technology has evolved it has taken on more qualities of the organic—indeed, today the incorporation of machinic components from cells and organelles as pieces of nanotechnology is standard fare; while at the same time our understanding of organic systems has been more and more in terms of assemblages of machines, particularly computational machines. Simultaneously with this "becoming-organic" of the technical object, the human role in this process devolves from that of an actor whose intentionality directs this dynamic to that of a mere operator who functions as part of a larger system.

Johnston's stunning overview of the recent history of work in computational science, robotics, cognitive science, and Artificial Life points to a convergence of problems and models, and a collapse of boundaries that makes Deleuze and Guattari's description of the "machinic phylum" seem like a map of the present rather than a cautionary tale for the future. Earlier I pointed to current work in cellular robotics, where researchers are inserting protein logic circuits into cells in order to direct the cellular machinery for engineering purposes. I used these examples to illustrate the notion at the heart of Hayles's and Hansen's work: informatics requires embodiment, and presumably an embodied (human) subject as the framer of information. In the trajectory that Johnston outlines, however, this is a temporary and indeed annoying stopgap. In discussing recent solutions to design problems in mobile robotics and other related fields, he points out that researchers are finding the solutions to their problems most efficiently by integrating evolutionary processes dependent on genetic algorithms and evolving neural networks, on self-organization and emergent complex adaptive systems, rather than depending on the layering of behaviors carefully hand-crafted by the designer of a "bottom-up" subsumption architecture, the technique pioneered by Rodney Brooks.

As Johnston argues, this approach puts the entire burden on the designer to decide how a desired behavior should be decomposed or broken down into simple basic behaviors. Researchers like Stefano Nolfi and Dario Floreano (and even Rodney Brooks himself) find this incremental layering approach constraining, and they are moving beyond it by seeking means to evolve higher forms of intelligence

9. Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (Minneapolis: University of Minnesota Press, 1987), p. 409.

"on their own." Increasingly, contemporary robotics seeks to produce complex behavior that emerges unexpectedly from local interactions among its various elements and in relation to a changing environment. Such global or higher-level complex behavior cannot be designed "by hand," so evolutionary strategies become the tools of choice. The main stumbling block—and the key issue for these researchers—is getting the designer further outside the construction loop, and ultimately removing the designer altogether. Johnston argues that, typical of the work now going on in the field, for Nolfi and Floreano "a more desirable solution . . . would be a self-organized process capable of producing incremental evolution that does not require any human supervision."[10]

The best way to develop intelligent artificial agents is simply to turn them loose and let them evolve. Johnston's depiction of the ways in which the current merging trajectories in computation, Artificial Life, and evolutionary robotics fit the picture of machinic evolution elaborated by Deleuze and Guattari and by some of the early members of the cybernetics movement may not engender the sense of apocalyptic alarm aroused by Ray Kurzweil or Bill Joy—but if his prognosis is correct, the face on the machinic phylum will not be human.

10. Stefano Nolfi and Dario Floreano, *Evolutionary Robotics: The Biology, Intelligence, and Technology of Self-Organizing Machines* (Cambridge, Mass.: MIT Press, 2000), p. 15.