# Resistance Is Fertile: Gesture and Agency in the Field of Responsive Media


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# Resistance Is Fertile: Gesture and Agency in the Field of Responsive Media

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The force that through the green fuse drives the flower
Drives my green age; that blasts the roots of trees
Is my destroyer.
And I am dumb to tell the crooked rose
My youth is bent by the same wintry fever.

The force that drives the water through the rocks
Drives my red blood; that dries the mouthing streams
Turns mine to wax.
And I am dumb to mouth unto my veins
How at the mountain spring the same mouth sucks.

The hand that whirls the water in the pool
Stirs the quicksand; that ropes the blowing wind
Hauls my shroud sail.
And I am dumb to tell the hanging man
How of my clay is made the hangman's lime.[1]

## Introduction

Accounts of language, languaging, and the construction of knowledge have turned on logic, on semiotics, on information and cybernetics. Can we appeal instead to notions of embodiment and mate-

1. Dylan Thomas, "The Force That Through the Green Fuse Drives the Flower" (1938), in *The Poems of Dylan Thomas*, ed. Daniel Jones (New York: New Directions, 1971), p. 77.

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riality that do not reduce to these other categories? Scholars such as Katherine Hayles and Mark Hansen have recently emphasized the need to rethink embodiment and materiality in an era saturated with digital media,[2] but attempts to reinterpret such notions have tended to slip back into the semiotic or informatic categories they try to exceed. Questions of gesture and agency in the presence of emerging technologies of performance have cast such notions in sharper relief. Given these concerns, it seems reasonable to expect that an account of gesture and agency informed by some direct experience with sensor technology, real-time systems, and computational media as applied to experimental performance could offer more insight to this inquiry. Moreover, since formal accounts of agency have tended to be framed within the categories of the cognitive, if not the linguistic, it seems that experimental projects with music, time-based visual art, fabric art, and theater would constitute fertile ground for phenomenological study.

Motivated by present concerns with embodiment and materiality, I pose the question: How do our notions of gesture and agency mutate in the presence of real-time, dynamically varying computational media? I refract this question through the experiences of building and playing in responsive spaces such as TGarden's TG2001, which was presented as a public experiment at Ars Electronica in Linz, Austria, and at V2 in Rotterdam.[3] What I bring into the conversation is a study of interaction and digital media, and some years of experience with building simulations, visualizations of differential geometric processes, and most recently with responsive media spaces. My 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, a-linguistic experience. Part of the strategy has been to materialize the argument in the same responsive spaces that we study, and to reflect upon their design and their performance. Consequent to this approach I suggest a way to

2. N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999); Mark Hansen, *Embodying Technesis: Technology Beyond Writing* (Ann Arbor: University of Michigan Press, 2000). For a recent work that richly explores these themes, see also Brian Massumi, *Parables for the Virtual: Movement, Affect, Sensation* (Durham, N.C.: Duke University Press, 2002).

3. The TG2001 responsive media space installation was built by a consortium of artists and engineers from sponge (USA) and FoAM (Belgium). See *http://sponge.org/projects/m3_tg_intro.html and http://f0.am/tgarden* for documentation of the performance-events as premiered in Austria and the Netherlands in the fall of 2001.

understand gesture, agency, and free play, and consider in what manner we can constitute material embodiment.

In this essay I first describe the TGarden environments as the prototypical examples of responsive media spaces, some gestural features of such environments, and the qualities of gesture on which I would like to focus, explaining why one may profitably defer resorting to linguistic categories. I then describe the materialization of gesture in physical movement and computationally mediated response, drawing for concreteness on the particular emergent technologies of computational media: real-time digital video and sound. And finally, based on this richer notion of open and multiply completed topological gesture, I draw a set of implications regarding agency in the presence of responsive media.

## TGarden Responsive Media Spaces

A TGarden is a responsive media environment, a room in which people can shape projected sound and video as they move. 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 5 meters above onto the floor, a space filled with sound already in a residual motion (see Fig. 1). The assistant tells the player only to listen as she moves to understand what effect bodily motion has on the ambient media. As the player moves, her gestures 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 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.[4]

TGarden was built to explore how people can *improvise* gestures out of dense, evolving fields of media. In ordinary informal conver-

4. The TG2001 sound and visual synthesis software 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.

Figure 1. Players in a TGarden, V2 Las Palmas, Rotterdam, 2001.

sation, you can spontaneously drag or pitch your speech to express irony, sympathy, and so forth. Similarly, in a TGarden, by waving your arm you write video or leave a trace in sound, and by moving about the space, solo or in concert with other people, you construct a voice for yourself out of a sound field that is summed from all the instrumental voices in the room. A TGarden supplies no discrete "alphabet" of visual or aural lexia. Quite the contrary: as you play, your continuous motions create an aural and visual "voice" for yourself out of the ambient perceptual field. As Lewis Carroll famously demonstrated with "Jabberwocky," a speaker can invent a novel word or phrase in verbal play that makes sense to the speaker's interlocutors even if the neologism has not appeared before in the lexicon and the pragma.[5] A responsive media space, augmented by real-time computational processes, enables the improvisation of meaningful gesture in more general modalities.

I call this invention of new audible, visible, or haptic signs *neosemy*. One of the aims of this essay is to show how neosemy is made possible by an open space of gesture and a malleable system of responsive media, and how openness and responsivity sustain agency in a nonschematized imaginary. In order to accomplish this, I will introduce, via the specific cultural and technological artifacts

5. Lewis Carroll, *The Annotated Alice: Alice's Adventures in Wonderland, and Through the Looking Glass*, ed. Martin Gardner (New York: Meridian Library, 1960), pp. 191–197.

of the TGarden responsive media spaces, a notion of topology that simultaneously amplifies certain ethico-aesthetic programs common to posthumanism and draws on richer but basic conceptions of topology which have yet to be fully explored in their rematerialization following Gilles Deleuze and Félix Guattari.

A large part of the impact of the TGarden as a phenomenological and theatrical experiment derives from careful staging and costume design—we are explicitly designing these spaces as in vivo experimental spaces of play. Notwithstanding the staged aspect of our installations, a crucial and central distinction between the TGarden and singular aesthetic or theatrical events is that the TGarden was designed to be an "instrument" that could be used to perform a large range of events with fluid and dense flows of media. We conceived it as a writing instrument in which people map their movement, not to ink or chalk or paint, but to varying fields of image, sound, and fabric. With such an instrument, we investigate how people can invent gestures freely, and how they coordinate their play without articulating actions or rules in ordinary language. I use "instrument" in multiple senses—as a collective prosthetic, as a means of visual and aural expression, as a machine for the transcription of gesture to sound and moving image, but also as a device for observing phenomena of performance. The "T" stands for transformation, time, and topology, among other things. By design, the TGarden constitutes an aesthetic and performative experiment for materializing some of the recent concerns with embodiment, materiality, gesture, and agency.

## Approaching Gesture

One could approach the phenomenon of gesture from many perspectives: gesture as language (linguistics), gesture as physical movement (kinesics), gesture as aesthetic and kinesthetic discipline (dance choreography or musical performance), gesture as culture-making (anthropology or philosophy). My approach interpolates between these poles, but leans toward taking gesture as a dense and multivalent phenomenon whose boundaries we should not draw overly sharply at the outset of the analysis.

Consequently, while I am interested in the question of agency and of how people autonomously create new entities (or not), I avoid taking the road through language, or at least the high road through grammar and syntax. One could fruitfully embed a discussion of gesture among the histories of the origin of language from Vico to André Leroi-Gourhan, but in the current investigation I examine it in the context of experiences with particular existing

responsive media spaces. First, let us recapitulate some prior interpretations of gesture with respect to linguistic categories.

*Gesture as Language and Gesture as Not-Language*

In the United States since at least the 1960s, the prevailing approaches among the scientific studies of gesture have unsurprisingly taken the perspective of language and linguistics. Work by researchers such as Ray Birdwhistell, William Stokoe, Edward Klima, and Ursula Bellugi paradigmatically started with the encoding of gesture as combinations of kinesic atoms analogous to the phonemes of classical linguistics, with sign language as the epitome of intentional gesture.[6] Modulo a few theoretical appeals to mental spaces, these approaches to gesture moved rapidly from the body's movements to English-language glosses in order to leap the analytic gulf between matter and symbol, body and word.

Gesture under the linguistic lens is parsable by assumption: there is a grammar according to which one can divide the stream of gesture into equivalence classes that obey (for the most part) some rules of position and combination. Even under the parameters of his much more elastically defined, decade-long project on gesture, David McNeill restricted his intricate observational taxonomy to "the spontaneous and idiosyncratic gestures that occur while one speaks."[7] Thus he tended to subsume gesture into the category of spoken language. But there is another way, a topological and field-based way to understand gesture independent of speech, some of whose consequences I will explore in this essay.

By suggesting that an activity so apparently central to language as writing could have an origin outside language, Roy Harris places himself very much on the periphery of his peer linguists. He alternatively treats writing as an environmental physical activity that coordinates a collectivity of humans. His argument for writing as part of a kinesthetic practice much wider than language per se suggests that the domain of signifying act need not be identified with what we ordinarily call language.[8] So, language—a systematic abstraction of human activity that assumes discrete "words" as atomic elements

6. Ray L. Birdwhistell, *Kinesics and Context: Essays on Body Motion Communication* (Philadelphia: University of Pennsylvania Press, 1970); William C. Stokoe, *The Study of Sign Language* (Washington: ERIC Clearinghouse for Linguistics, Center for Applied Linguistics, 1970); Edward S. Klima and Ursula Bellugi, *The Signs of Language* (Cambridge, Mass.: Harvard University Press, 1988).

7. David McNeill, *Hand and Mind: What Gestures Reveal about Thought* (Chicago: University of Chicago Press, 1992), p. 36.

8. Roy Harris, *Signs of Writing* (New York: Routledge,1995), pp. 4–7.

and frames them in structure-based rules—is not a category within which we necessarily splay out gesture.

The linguistic model of gesture would have us identify "truth-preserving" assignments of every gesture to a discrete and differentially determined sign bearing meaning—but this raises a host of well-known problems, the same that render mysterious the connection between language and experience. Let me cite two problems just to illuminate the minefield. First, there is the parsing problem: Where and when does one gesture end and another begin? To decide a priori that a certain pattern of data from a sensor attached to a hand, bounded in amplitude and time, corresponds to the gesture for "hello" is to commit two errors. One is to make an arbitrary cut in phenomena prior to the data—epistemologically putting the cart before the horse. We assume that there is a well-defined gesture associated with "hello," when that may not be the case. A spoken word may not systematically correlate to any bounded, determinate movement; certainly it is not necessary. A characteristic way to rationalize such an analysis is to first define away noncorrelate movement as mere "gesticulation"—noise gesture. The other error stems from what I call the river-parsing problem that afflicts any discretization procedure, such as cutting a geographic map into a grid of tiles: cities and pointlike features can be represented neatly in an appropriate grid, but extended features like rivers or mountain ranges that are nonlocal patterns cannot be so neatly accommodated. In practice, geographers usually adjoin such nonlocal unities by labeling them with proper names in a gazetteer. The analogous problem crops up in general with any representation by a lattice or a matrix: nonlocal entities cannot be represented by systems of local, independent units.

The second and deeper problem is that a correspondence theory does not explain how words, signs, or gestures have the power to cause material changes in the world and in the bodies of the people who inhabit them. How is it that some gestures are more expressive than others? How do we change the symbolic content of our world by our gestures? Among the more plausible attempts to bridge symbolic process with materiality was C. S. Peirce's theory of material logic in which "[t]he idea itself has its material quality which is the feeling which there is in thinking."[9] Twenty years later, Peirce substantiated his notion of thought-as-feeling by adjoining a physical and physiological theory that characterized feeling as a "breaking up" of a habit present in all kinetic matter, but particularly in proto-

9. Charles S. Peirce, "On the Nature of Signs" (1873), in *Peirce On Signs*, ed. James Hoopes (Chapel Hill: University of North Carolina Press, 1991), p. 142.

plasm.[10] This breaking up of habit in turn amounted to the chance interruption of customary movement according to physical law, prefiguring the discovery of the chaotic dynamics of deterministic systems in the next century. Prescient as Peirce's mechanisms may be in light of the current program to locate consciousness in nervous tissue, they retain an odor of unwarranted reduction. Furthermore, chance cannot exhaust or determine the space of nuanced gesture. In the end, the theory still seems not to account for social and aesthetically inflected gesture. Is there another way to account for such gesture?

In his meditation on gesture, *Les gestes*, the philosopher Vilém Flusser recapitulates the problems generated by a dualist ontology:

> According to the dialectic vision, one affirms the profound conviction that we are embedded in two realities very different from one another, whose interaction is incomprehensible. . . . A conviction which manifests itself, for example, in the phrase "I have a body."[11]

The syntax of such a statement encodes the dualist epistemology of the cogitating subject (other than the body) that stands in a relation of ownership to the body. Indeed, the syntactic pattern subject—verb—object reflects this dualist epistemology. The paradigmatic modern resolution to this dualism was to appeal to a dialectic between spirit and matter. Flusser goes on to argue that one could free oneself from such a syntactically bound framework by recourse to other, "nondialectic" language structures, such as those of film and video:

> Out of the grammar, thanks to the filmic medium, we can see concrete phenomena, of the movements in their environment, of which one deciphers the signification as being, as for example, "to write" or "to eat" or "to photograph." . . .
>
> When one tries to translate these simple observations into words, things become complicated and impenetrably opaque, because then one is obligated to ask "What is it that moves?" and to respond (in the case of the gesture of writing, for example): "the fingers, the keys of a writing machine, the muscles, the nerves, the glandular secretions, the mechanism of the machine, etc." without ever being able to finish.[12]

10. Charles S. Peirce, "Man's Glassy Essence (1892)," in ibid., pp. 227–229.

11. "Par 'vision dialectique' j'affirme, surtout, une conviction très profonde selon laquelle nous sommes plongés dans deux réalités très différentes l'une de l'autre et dont l'interaction est incompréhensible, bien que partout et toujours présente. Une conviction qui se manifeste, par exemple, dans la phrase 'j'ai un corps'" (Vilém Flusser, *Les gestes* [Paris: D'ARTS École Nationale Supérieure d'Arts Cergy et Art 95 + Éditions Hors Commerce, 1999], p. 186). (All translations from the French text quoted are my own, with the kind assistance of R. Carotti.)

12. Ibid., p. 188.

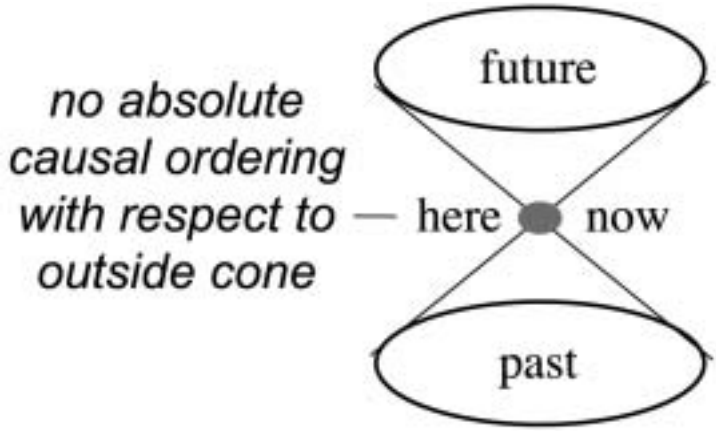


Figure 2. Past and future and non-causal regions around an event.

So Flusser reminds us that many mysteries arise if we adhere to a dialectic vision of the world. Let me add that the dialectic vision often implicitly demands a locally linearly ordered, pathwise causality. By this I mean the property that if you restrict your attention to a sufficiently small portion of the world, any two events within your scope of consideration have a causal path leading from one event to the other (Fig. 2). But life, whether bureaucratic or domestic, is much less pathwise causal than that.[13] Technologies of language such as grammar, syntax, lexicon and morphology only thicken the mystery. Indeed, Roy Harris's (and Wittgenstein's) criticism of linguistics is that it believes in meta-languages which are in fact inadequate as descriptions of everyday language.

In place of these attempts to bridge language or logic with the material, I will take up the stuff of gesture—its material topology—and elaborate what Félix Guattari glimpsed and labeled as the a-signifying semiological stratum.

In this same volume, Brian Rotman eloquently articulates the case for gesture as not-language, for gesture as the silent other to speech, that may flag and shadow verbal language to various degrees of independence. Rotman reminds us of David McNeill's and Adam

13. We know already that pathwise causality does not hold for space-time in the specific case of relativity theory with a restricted notion of causality based on the null cone of the metric. From special relativity we know that in a Lorentz space-time no simultaneity—or equivalently, no absolute causal ordering—can be maintained between a given event and any event outside the light cone of that given event. This is not the fuller notion of determination to which Flusser appeals, but it already demonstrates the problem.

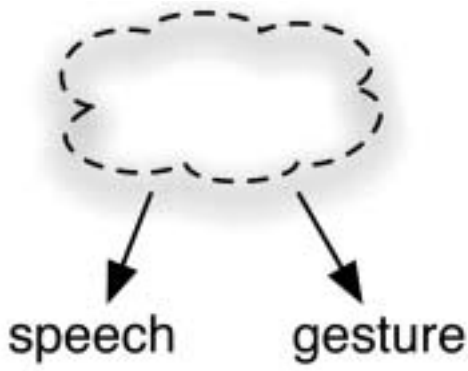


Figure 3. McNeill: Singular thought prior to speech and gesture.

Kendon's unidimensional "continuum" of gesture: Gesticulation—Language-Like Gestures—Pantomimes—Emblems—Sign Languages. For McNeill, "gestures . . . are idiosyncratic spontaneous movements of the hands and arms *accompanying* speech."[14] McNeill and Kendon's single axis emerges as an artifact of arraying all the phenomena of gesture against the one index: the degree of salience of speech. However, *any* function of a single independent numerical real parameter is necessarily unidimensional; therefore Kendon's continuum, however convenient as an analytic classification, is only an artifact and only one thread in the ocean of gesture. McNeill claims that his empirical evidence indicates that there is something that precedes both gesture and associated speech (Fig. 3). Certain waves of the hand systematically precede, with high correlation, certain spoken phrases. Yet while this certainly suggests that the gesticulatory movement that accompanies speech essentially doubles the speech, correlation does not warrant the invention of a prior causal entity. This linguistically inflected attempt to leap the gulf between logos and experience relies on a questionable appeal to correlation.

Perhaps gesture should not be understood in any particular relation vis-à-vis language at all. What if we take gesture as traced by, but not reduced to, dumb physical movement? What if we investigate gesture in all its culturally inflected performative potential in a responsive media space supplied with computational affordances?

There is some precedent for this from the domain of cognitive science, notably in the theory of distributed cognition as introduced by Edwin Hutchins, based on ethnographic studies of cognitive infor-

14. McNeill, *Hand and Mind* (above, n. 7), p. 37. Emphasis mine.

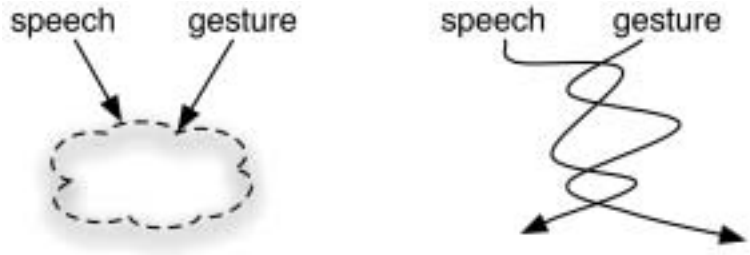


Figure 4. Two alternatives to McNeill's model of singular thought prior to speech and gesture: coherent singularity constructed ex post facto, or speech and gesture as independent processes.

matic activity in the workplace. Hutchins's project is concerned with explaining cognition in problem-solving activity based on information represented as "physical-symbols"—signifiers that can in principle be read and written by a mechanical process. His major project in the field of cognitive science—he places himself within the field, and acknowledges his first training in the area of cognitive anthropology[15]—regards the locus and structure of cognition in naturally occurring unconstrained social conditions, "cognition in the wild." For Hutchins, cognition does not just occur between the ears of a human being but is distributed throughout the environment. In fact, it has no one locus. For this reason his argument is also glossed as "distributed cognition." Hutchins's book is based on long observation of navigating and piloting actions taken by teams of naval officers and sailors. The tasks are those involving calculating, plotting, judging evidence, and making decisions. Hutchins discovered that much of this "thinking" actually takes place in the material, nonhuman parts of the ships' architecture, tools, and information systems, and he makes much of this discovery.[16]

15. Edwin Hutchins, *Cognition in the Wild* (Cambridge, Mass.: MIT Press, 1996), p. xii.

16. It is illuminating to contrast Hutchins's epiphany with Andrew Pickering's elaborately articulated theory of disciplinary and material distributed agency in *The Mangle of Practice: Time, Agency, and Science* (Chicago: University of Chicago Press, 1995). Bonnie Nardi, herself a researcher in the field of human-computer interaction, quotes Christine Halverson's characterization of Hutchins's notion of cognition as "*computation* realized through the creation, transformation and propagation of representational states," and adds: "Neither interpretation nor imagination, (nor many other cognitive capabilities) however, can be reduced to computation. 'Cognition' in distributed cognition takes on a specific limited meaning in which machine processes determine the highest level of 'cognition,' as cognition-as-computation must stretch across people and things"; not everyone in HCI is convinced by a simple theory of "things that think" (Bonnie Nardi, "Coda and Response to Christine Halverson," *Computer Supported Collaborative Work* 11:2 [2002]: 274).

Hutchins tries to rehabilitate cognitive anthropology by putting culture back into the equation, but his concern is still with *cognitive process*. He writes:

> One may focus on the processes internal to a single individual, on an individual in coordination with each other, on an individual in coordination with a set of tools . . . , or on a group of individuals in interaction with one another and with a set of tools. . . . Each system [*sic*] produces identifiable cognitive properties, and in each case the properties of the system are explained by reference to processes that transform states inside the system. The structured representational media in the system interact in the conduct of the activity.[17]

Notice the vocabulary of representation, (discrete) state, cognitive process, system, and tool—all terms of art in cognitivism. Although in his introduction Hutchins explains that his project to extend a model of cognition beyond the brain to the environment of tools is motivated by a desire to readmit culture into social science, his project remains freighted by a sharply limited view of experience. It is most revealing to see in his chapter on organizational learning and teamwork diagrams of socio-technical system design in which "System" (with a capital "S") appears as the largest element in a diagram as abstract as any flowchart representing the logic of an ideal Turing program.[18] The emphasis in his group's approach to machine-mediated human activity lies still on *cognition* as a computational and ultimately rationalizable procedure.

For the purposes of my project, I begin this consideration of gesture without appeal to any mental process, or to cognition as a prior phenomenon, however located. To those who might object that nevertheless I am resting my discussion on the computational, I would paraphrase Wittgenstein: Don't regard a computational (computationally mediated) gesture as a gesture of computation.[19] To be clear, nowhere will I claim that what people do is equivalent or reducible to computation, whether local or distributed, in vitro or in the wild.[20]

17. Hutchins, *Cognition in the Wild* (above, n. 15), p. 373.

18. Ibid., pp. 346, 349.

19. "Don't regard a hesitant assertion as an assertion of hesitancy" (Ludwig Wittgenstein, *Philosophical Investigations*, trans. G. E. M. Anscombe [New York: Macmillan, 1958], p. 192e).

20. For a strong advocate of the opposite stance, see Stephen Wolfram's discussion of the computational equivalence principle in *A New Kind of Science* (Champaign, Ill.: Wolfram Media, 2002), p. 715.

*On Smoking a Pipe*

Meditating on gesture as movement saturated with cultural aesthetic value, Vilém Flusser examines contemporary activities such as smoking a pipe, making a telephone call, and phenomenological variants of seeing after photography, film, and video. His project is motivated by two hypotheses: first, being in the world, *existence*, is manifested in gestures; and second, at any moment one could observe a gesture that one has never observed before. Put more symmetrically between observer and doer, effectively novel gestures can be improvised in any locally bounded context or part of the world. Flusser is less interested in the mechanism than in the phenomenology of gesture; accounts of how gestures are performed are unimportant, whether the causal theory is drawn from physiology, sociology, or psychology.

Ultimately, for Flusser, the cultural valences of gesture are ethical-aesthetic ones, and thus we arrive at the heart of the difference between his treatment of gesture and Hutchins's ethnographic investigation. The interesting feature of the motions of smoking a pipe is that they do not accomplish any useful task, and they are not gestures of deduction or information-gathering. Rather, the gesture of smoking a pipe is a gesture of pleasure, and gestures of pleasure are motivated simply by living for living's sake, as Flusser puts it. Moreover, his approach to gesture is to treat it as signification, and signification always occurs in the intersubjective domain. Indeed, we make much headway by sidestepping the gap between sign and body, but we can go much farther. How we do this will emerge in the discussion of how gesture's *incompleteness*, which is my more precise characterization of one aspect of gestural openness, ultimately allows multivalent completion in a way that I shall elaborate below in the section on movement and software. But first, I turn to consider in what sense gestures in a responsive media space like a TGarden can be material and palpable.

## Gesture as Material

September 11, 2001. As you walk into your workplace, you pass groups of people talking out of earshot about some news that you have not yet heard. Their mien, their posture, the temporal ebb and flow of their movements all signify some change in the condition of the world, even before you know what these significations mean. In other words, for you their poses, movement, and expressions are presemantic—but this phrasing is tangled in a dualist language, the dialectic vision that Flusser also wished to sidestep.

In *Chaosmosis*, Félix Guattari identifies a stratum in the "enunciative substance" in which such processes work below, or outside, the level of meaning—namely,

> 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? This continual emergence of sense and effects does not concern the redundancy of mimesis but rather the production of an effect of singular sense, even though indefinitely reproducible.[21]

Mathematicians might view a superficially misleading label like "a-signifying semiotic" as an infelicitous notation, but the notion is a fruitful one. There is a magmatic domain in which signs as things and things as signs evolve without, or perhaps prior to, meaning as language—a domain that Wittgenstein recognized as a coronal lifeworld around language, but about which he could not speak. The TGarden was constituted as an apparatus in which to experiment with such processes of "a-signifying" enunciation. As such, the TGarden environments provide glimpses of what things, what substances, and what *subjects* can be shaped and made palpable by gestures. Below, in discussing movement and software, I describe in more detail how they do so, but before we move entirely into the machinic let us more closely examine Guattari's conception of the magmatic domain.

Guattari conducts a poetic investigation of subjectivation from a-signifying as well as signifying fields of enunciation.[22] In order to do

21. Félix Guattari, *Chaosmosis: An Ethico-aesthetic Paradigm* (Bloomington: Indiana University Press, 1995), p. 37.

22. Under a linguistic account, every language is described by a set of terms and rules that together constitute the description of the formal structure of that original language, called an object language. For example, the statement that "'Ouch!' is an exclamation" is a statement in the meta-language for everyday English. Grammar is a systematic set of rules in the meta-language. Given a language L, we say that the meta-language M[L] is one degree higher than its object language L: L → M[L] → M[M[L]] → . . ., where in the sequence L → M[L] , L is the object language, and M[L] is the meta-language describing L's structure. The problem, as Hjelmslev tentatively discerned in the last chapter of his *Sproget*, was that this potentially leads to a dizzying tower of ever-more-abstract meta-languages: Louis Hjelmslev, *Sproget: Language; an Introduction*, trans. F. J. Whitfield (Madison: University of Wisconsin Press, 1970), pp. 133–136.

so, he rehabilitates Louis Hjelmslev by the audacious homomorphism

(form of Expression) ~ (form of Content),

commenting:

> I intend to consider a multiplicity of expressive instances, whether they be of the order of Expression or Content. . . . this would involve putting a multiplicity of components of Expression, or substances of Expression in . . . polyphony.[23]

After remarking that the usual conception of such forms of Expression and Content is too bound up with language, Guattari proposes that this positive conception would "allow us to integrate into enunciative assemblages an indefinite number of substances of Expression, such as biological codings or organisational forms belonging to the socius."[24]

Indeed, the TGarden is designed to sustain local/individual or distributed/collective expressions at different degrees of virtuosity. This requires that the system be built as a system paradoxically open to the importation of social practices, such as sedimentations of informal as well as formal performance techniques. Dancers and musicians import expert responsivities to rhythm and spatial symmetries, but nonprofessionals also bring their kinesthetic expectations and competencies, to which the media synthesis instruments, software, and electronics respond. It is in this sense that a TGarden or any so-called immersive space is necessarily porous to histories imported by participant bodies.

But to return to the theoretical point of this section: This Guattari-Hjelmslev homomorphism between forms of Expression and forms of Content (see Fig. 5) introduces a categorial identification that is unthinkable under both structuralist and poststructuralist metaphysics, unremarkable under a formal symbolic processing paradigm

It is this concept that inspired Deleuze and Guattari's remark that the problem with linguistics is not that it is abstract, but that it is not abstract enough (Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* [Minneapolis: University of Minnesota Press, 1987], p. 91). But there is a simpler approach: this problem of degrees and of the towers of abstraction emerges as an artifact of algebraic representation. In Hjelmslev's discussion of Sausssure's invention of the phoneme, he refers to linguistic structures as algebraic, by which he means the use of discrete tokens for the primitives of a language and a set of rules governing their combination according to one or a few operators, the canonical operator being concatenation: G-O-D → GOD. But the tower of meta-language invokes the same Gödelian and Russellian problems of regress that mired set theory and logic.

23. Guattari, *Chaosmosis* (above, n. 21), p. 23.

24. Ibid., p. 24.

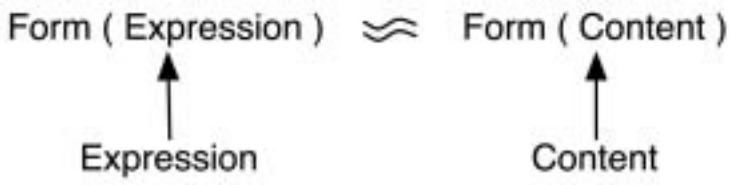


Figure 5. Guattari-Hjelmslev homomorphism.

(because everything is lost, so to speak, in the translation to linguistic form), and deeply provocative when we relinquish the structuralist residue of linguistics in favor of embodied materiality. Above the base manifolds of expression and content, Guattari recognizes forms of machinic enunciation that materialize ethico-aesthetic performance and make possible the formation and dissolution of objects and subjects.[25] The TGarden materializes such a machinic complex and is just such a place for experimental alinguistic enunciation.

But the apparently paradoxical form of Guattari's portmanteau name for the presemantic impels us to find a smoother way to understand this material magma of the world. Perhaps materiality is better treated as an effect, rather than as a quality in itself. A substance—whether symbolic, mathematical, or physical—that exhibits causal temporal responses characteristic of physical matter can be felt as material by a nexus of coordinated gestures, conventionally indexed by a "subject." We witness this phenomenon quite palpably in the TGarden environments in the way that music and organized sound impel people to move and to cogenerate music with the responsive sound-synthesis program.[26]

This essay on gesture is part of a longer exploration of materiality and agency. In that larger project we ask what does materiality comprise, and what is the relation between materiality, embodiment, and agency, especially in the presence of computational or active matter? Materiality implies friability—susceptibility to decay—and

25. Discussing the formation of objects, Foucault insists that discourse objects should not be reduced, either to things in themselves or to words: Michel Foucault, *The Archeology of Knowledge* (New York: Pantheon Books, 1972 (1971)), pp. 47–49. And in the chapter on the enunciative function: "The statement cannot be identified with a fragment of matter; but its identity varies with a complex set of material institutions" (ibid., p. 103). By treating gesture in this Guattarian mode, we can nuance an investigation of enunciation at an intermediate resolution between Foucault's "perishable individuals" and material institutions.

26. More precisely, I should say the *limits* of sequences of subjects or objects rather than subjects or objects per se, because TGarden was designed to start with human, image, and sound in continua, out of which entities would emerge only in the course of movement, gesture, and response.

tangibility, the impact of material upon sensate material (generalized skin). Autonomous processes of growth and decay, thickening and thinning, and phase transitions between states of matter need not be organic a priori. Indeed, as with materiality, the organic also could be treated as an effect rather than a predicate. In fact, poetic extensions of the living organic to this abiotic sense figure strongly in the aesthetic experience of the TGarden.

Given these considerations, I turn now to examine gesture as material in a physically and computationally responsive media space.

*Movement and Software*

The TGarden uses the notion of observables, which are the values of operators upon distributions of fields of visual, aural, fleshy, and other matter.[27] As far as the sensors and computational system are concerned, certain observables, even if they are generated in software rather than by flesh or physics, are treated the same as, say, accelerometer data or location data, simply because the system cannot distinguish "physically generated" observables from "software-generated" observables.

Sensor data generated from the players' physical movements percolate through statistical code that operates both on single streams and on aggregates of streams. These statistical measures are then mapped to media engines that synthesize responses in audio and video. It is centrally important both conceptually and operationally that, by design, the TGarden's software builds no semantic, no humanly legible model of predesigned categories of human gesture. A telling aspect of how the accelerometer data streams are treated in the TGarden is that in the code, there are essentially no IF-THEN statements. There is no statement like "if value_of (sensor_channel_9) > THRESHOLD_9 then signal USER_IN_EXPERT_MODE." To draw an analogy: in a conventional piano, there is no mechanical lever that trips when the pianist displays a certain degree of virtuosity; the piano responds to the musical gestures of the pianist, and makes no calculation, no inference as to the pianist's virtuosity, musicality, or intent.

Indeed, the ambient MAX environment itself is a data-flow programming environment modeled after the flow of signals through bank after bank of sound-processing instruments connected by signal-conducting patch cords, except that the model is generalized

27. I borrow the term and the notion from classical and quantum mechanics. See Anthony Sudbery, *Quantum Mechanics and the Particles of Nature* (Cambridge: Cambridge University Press, 1986), p. 52.

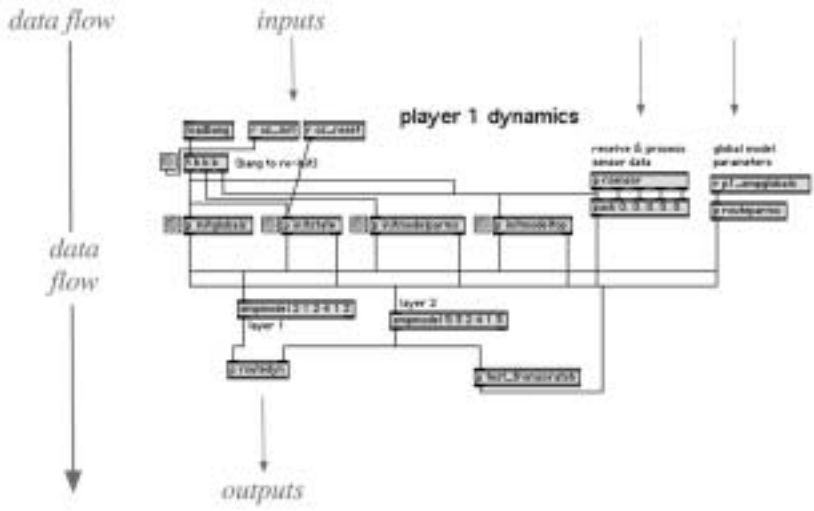


Figure 6. Sample MAX data-flow code from TGarden's media choreography system.

from sound to include sensor data and other types of data. (See Fig. 6.) By convention, the MAX programming environment expresses a set of parallel and branching flows of data "falling" from top to bottom through the net of operators that transform the data as they course. Moreover, the temporality of these processes is explicitly multiplied by the order in which the operators are connected; in fact, multiple metronomes and gates can be created and placed arbitrarily in the program net in order to cycle or pump the flow of data. This stands in sharp contrast to a classical procedural programming language in which the sequential syntax of imperatives like "define variable n to be of type *t*," "assign value of expression *y* to *n*," and "repeat this subsequence of actions *n* times" reflects the conceit of an atomic subject—"the computer"—stepping through and executing the instructions one by one in a unidimensional sequence. This syntactic difference between MAX and a conventional procedural programming language like C materializes a profoundly different way to respond to activity, a response that is based not on labeling movement data and then subjecting them to a grammar-driven interpretation that in turn is subject to predicate calculus logic, digital programming based on the same abstractions underlying formal linguistic models, but rather on the accumulation and proportioning of instantaneous and aggregate measures that index friction and resistance. In this we encounter some of the alinguistic, "a-signifying,"

presemantic aspects of the responsive media. This point bears underscoring.[28]

The TGarden software *tracks* gesture rather than recognizes gesture, because at no place in the software is there a "model" that codes the gesture at such a high semantic level, to borrow cognitivist terminology, as "waving hello" or "smoking a pipe." Under this technology of gesture tracking, movement makes meaning, and no intentionality need be inferred. The software does not infer what the player means by her gesture, it merely tracks the gesture and continuously synthesizes responses. So what we have done is to set aside entirely the problem of inferring human intent from behavior, or more generally from observables. Yet by providing and even thickening the sensuous response, we make fertile the substrate for agency. This approach remains agnostic as to whether movements are intentional; the responsive system simply does not need to know.

So, returning to an earlier observation, how can we understand *resistance* in software? As data pour in from the sensor inputs, the data run through chains of operators, written in a real-time media-tracking, transformation, and synthesis-programming environment called MAX, which is based on a data-flow graph. Some of the numbers are shunted back into recirculant paths of processing. All this work forms a textured resistance to the movement of data in the software, a multidimensional resistance whose temporal extents are of course small, but in repetition are perceptible to the human players. In cases of extreme latency players perceive a delay, but more often, in the normal course of operation, this is tangible as rhythm and temporal texture. Analysis of the complexity of algorithms teaches us to measure computational procedures by space—machine storage memory—as well as by time. The overarching factor remains the computational logic of the procedures themselves, which governs the perceived dynamics and resistances of the media.

Thus for the purposes of this essay, a gesture is more than the physical movement—it comprises also a temporal texture and a multivalent set of activations in the machinery. In a responsive media space, the sensors, the data networks, the transmission protocols, the statistical functions, and the media-synthesis engines are all exercised by the data pushed by the movements of the players' limbs and bodies. A player hops, rolls, jumps, and promenades in order to play the media. It is also in this sense that gesture is material, as

28. One might object that abstractly a data-flow program and a procedural program are Turing-equivalent, but such a reduction would be blind to the expressive and temporal implications of the sharply distinct syntax.

Figure 7. Rodney Brooks with robot.[29] With permission of Peter Menzel Photography, © 2003 Peter Menzel.

physical movements' effects percolate through the intricate layers of software processes. In a responsive media space, players gesture through computational media as well as air and fabric.

At this stage let me point out a crucial distinction between this approach and Rodney Brooks's subsumption architecture. Under Brooks's subsumption paradigm for an autonomous robot, low-level computational elements realize only the simplest of stimulus-response functions, such as "reverse motor when leg is blocked"; higher-level nodes could be of the form "bark when motor is reversed." Brooks's original model was the insect, but in the end it seems that he and fellow roboticists wish to make companions in their own image (See Fig. 7). In a TGarden, however, there are no prior assumptions as to what constitutes body or what constitutes self.

There is a circulation of movement and effect in a self-observing system like the TGarden (Fig. 8). When the player moves, her motion sends cascades of effects that modify the visual images projected on the floor around her. But the vision system that calculates her location based on what the video camera sees will also necessarily treat the computer-synthesized patterns projected on the floor as part of the visual scene, just as "authentic" as the image corresponding to her body. By applying 3-D vision techniques, one could try to distinguish between the part of the video camera image that "belongs" to her body and the part that is a projection of computer-synthesized video, but in practice that is difficult. In a deep sense, it is in principle impossible: to the camera, a green dot is a green dot is a green

29. *http://www.ai.mit.edu/projects/humanoid-robotics-group/cog/overview.html.*

Figure 8. Flow of gesture through a TGarden responsive space: People in a room → {Sensors, Camera} → Computer → {Speakers, Projector} → People in a room.

dot, whether it comes from the eye of a player, or is generated by a stuck pixel on the LCD screen, or is an artifact of the video-synthesis graphics software. As Humberto Maturana and Francisco Varela observed, at the level of neural electrophysiology, not even organic neural systems distinguish between neural stimulation due to signals from the "outside world" and signals generated by the body itself.

*The Topology of Gesture*

In light of these more concrete descriptions of gesture in a responsive media space like TGarden, what can we say about the space of all gestures in such a context? By "space" I mean not the nominally three-dimensional Euclidean space in which players move, but a set with characteristic and definite features. Such a set may be of possibly arbitrary or infinite dimension, or may not be a space measured with dimensions at all. "Space" sometimes carries connotations of boundary or some other feature of finiteness, but finite boundedness is not a necessary feature of a space. In fact, my argument works better when the space admits, in some important respect, an infinity of variational potential. In this section I describe some of these possible infinities and openness.

While I do wish to say something about the features of gestures, I will avoid a fixed taxonomy which would simply obscure the dense,

overlapping kinetic continua of gesture under a deceptive "alphabet" of basic and compound "gesture." In particular, we must avoid fixing a priori the equivalence classes of gestures, based on some fixed set of features that qualify the set of possible gestures. That would merely propagate Saussure's problematic segmenting of ideas and "sound-images" into parallel sequences of disjoint contiguous units.

A methodological note: I use "topology" in its full but not exclusively mathematical sense of a set with an open *basis*: a family of subsets (called "open") which is thick in the sense that arbitrary unions and countably infinite intersections of members of this family are also in this family of subsets. It is important to realize that this notion of topology is immeasurably more ample than the graph topology familiar to computer science. With a graph or network—the representation held by computer scientists, and now widely propagated as metaphor and model into other discourse networks—many of the richest aspects of topological space evaporate. Density, proximity, continuity, and nuance are comprehensible phenomena with topological sets. (And even in the twilight of the discrete, I should reiterate that a topological set is far more generous a notion than computer science's most general object, the enumerated list.) Formally, topological spaces include spaces of infinite dimension and of noncomputable functions, transformations that cannot even in principle be operationalized by any finite procedure. That said, I introduce this full notion of topology not for formal reasons but in order to sustain conceptions of gesture, agency, and collectivity rich enough to account for our phenomenological experiments.[30] Having quickened the batter, let me now consider the gestural topology, materially sustaining nuance and improvisation.

Wave a hand about as you walk. The most mundane feature of our gestural experience is that it is continuous—your hand moves without interruption in being (existence). Stretch out your arm and open your hand wide, as in the "paper" shape of the scissors-rock-paper game. When you open those fingers into the "paper" shape, your opponent rarely objects if the fingers are crooked a little more or a little less; variation through a continuous family of shapes is allowed without question. In other words, there is a nondiscrete equivalence class of "paper"-shaped hands that could be used when playing the paper-rock-scissors game. Now wiggle the fingers slightly, but

30. I am drawing conservatively upon the few intuitions from elementary point-set topology that seem adequate to open up this exploration of gesture and agency. For a fresh and well-motivated introduction to topology as it is used in much richer fields of mathematical practice, see Klaus Jänich, *Topology* (New York: Springer-Verlag, 1980).

staying within that equivalence class. At what point is your hand no longer "paper"? In fact, there is no sharply delimited boundary across which that shaped hand can be said to no longer be gesturing "paper." This openness is characteristic of what mathematicians call a topological open set.

In light of this example, we see that in the space of gestures, a given gesture can belong to an open continuum of gestures—that is, a continuum in which every point can be contained inside an open neighborhood strictly interior to the continuum.[31] Intuitively, you never reach the limit boundary from inside such a set. It is important to see that all of this prior discussion would work if we replace a motionless hand shape by a hand movement such as the wriggling of fingers. So this topological conception of gesture works as well for motile gestures.

A software system that *classifies* gestures unambiguously into categories that disjointly partition the space of all gestures (if that were to make sense) would need to sharply define the boundaries of each equivalence class and apply the logic of the excluded middle. A hand motion could be classified as *either* "hello" *or* "come here," but not both. As we can see from our earlier examples, this is practically difficult. The machine classification of signs falls under the jurisdic-

31. I deliberately use "open" in its technical sense, since this is quite powerful for our purposes. However, the proviso is that we can discover a topology in the sense of a family of sets that we can call "open" satisfying the axioms for a topology. For every sign $s$ in a set $L$ there is an open neighborhood $U$ containing $s$ such that $U$ is a subset of $L \setminus \partial L$ (the set $L$ excluding the boundary of $L$). (While this is a very compact notion, the technical challenge is to construct an environmental performance instrument that actually works along such lines. That is a large technoscientific project being conducted in parallel with this theoretical investigation of gesture and agency.) This offers an alternative to seeing closeness not in terms of similarity but in terms of the topological notion of an open neighborhood. Topology is not equivalent to graph theory, but builds on the more ample domain of set theory.

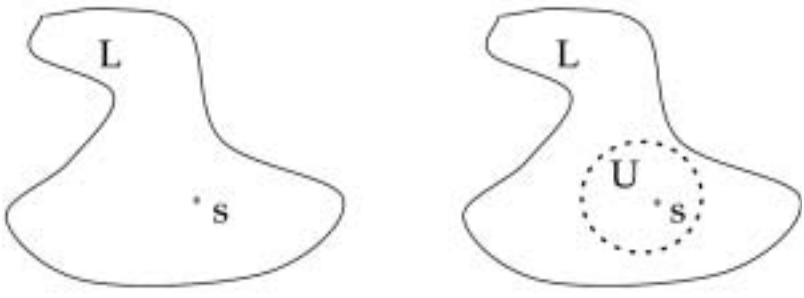


Figure 9. A set $L$ containing an element $s$, and a neighborhood $U$ in $L$ containing $s$.

tion of the active field of computer science known as pattern recognition.[32] My goal, however, is not to raise a technical question, but a conceptual one. We can draw a lesson from the difficulty and magnitude of the challenge presented by dance and performance environments such as the TGarden responsive media space to current techniques of pattern recognition. The strategy is not to "recognize" gestures according to some classificatory scheme, but to map bodily movements alinguistically and continuously to perceivable responses. Under this form of gesture-tracking with multivalent completion, response can be as actively reconstructed as the retelling of a dream, as any act of memory is a retelling of a dream.

*Completing Gesture*

In his essay on the gesture of smoking a pipe, Flusser distinguishes gestures by their intention: "Every classification of gestures could be a classification of forms of life: of gestures toward the world (work), of gestures toward others (communication), of gestures as ends in themselves (art)."[33] His most valuable insight is to cast gesture relative to an end, to treat it as a phenomenological relation rather than a self-contained object. In phenomenological terms, one could say that an "end" of gesture is the content of an act of consciousness, "end" being understood in its multiple senses of purpose, direction, and completion. But in order to accommodate gestures that may not have an articulated intent or purpose, I prefer to avoid measuring gesture against consciousness, at least in this current investigation. So, let us think of gesture not as an entity in itself but as a relation, as an open entity.[34] Here we use "open" not to qualify a set of gestures, but to qualify a gesture, in itself—so, to be precise, "open" in this context means that a gesture invites completion. But a gesture does not occur in a vacuum. The world, being dense with affect and effect—which Guattari identifies together, according to his ethico-aesthetic ontology—responds to every gesture. Or to put it more symmetrically with respect to the flow of agency, every gesture effects response. When you draw your fingernails across a fabric, you hear the scratch generated by the physics of the cloth. When a player dancing in a TGarden spins across the floor, the arc of her motion continuously perturbs the sound that is generated and the mov-

32. For a canonical reference text on pattern-recognition techniques, see Richard O. Duda, Peter E. Hart, and David G. Stork, *Pattern Classification*, 2d ed. (New York: Wiley, 2001).

33. Flusser, *Les gestes* (above, n. 11), p. 51.

34. I thank Niklas Damiris for the key insight that inspired this interpretation of gesture.

ing images projected about her feet come to a boil as she lifts her arm. In such a responsive media space, the imaginary physics is computed as a response partly to the movement of the people dancing within it and partly to its own dynamics.[35]

I should stress that not every computed response has a physical quality to it. The TGarden is designed with energy-minimizing physical models that continuously evolve under the joint action of autonomous processes and the movements of the human players in the space as observed by the sensors, so every movement by the player opens a *potential* gesture that is completed in the world, perhaps multiply completed. Gestures can be completed by other subjects, or by the world as a set of continuous fields. Now this completion does not have to happen later in perceived time; it may occur *concurrently*, as we shall see when we consider the temporal aspect of gesture's materiality. Think, for example, of the buzz against your finger as you scratch across a piece of sandpaper: the buzz sounds and varies continuously with your finger's motion. One of the deepest aspects of tangibility is the sense of temporal contiguity. What is it about the medium—the stuff—of gestures that would allow such openness and concurrent completion?

In order to understand that, we turn to the embodying aspect of gesture. By embodying, I mean that the gesturing conjures the gesturer, analogous to how performative theories by Judith Butler and feminist scholars have more specifically constructed gendered bodies. In our context, we consider the gesturing body as the sum or resultant of the gestures. We see this already with the unison bowing in the string sections of an orchestra, and the moments of ensemble movement in a dance. Such construction also occurs on the single fleshly body of an actor, of course. For his film *Umberto D*, Vittorio de Sica fished out from the ordinary, unrehearsed, *unintended* movements of a nonprofessional actor the character that was the protagonist. According to his neorealist episteme, de Sica believed he was discovering the character within the actor, as Angela Dalle Vacche put it in her analysis of this cinema of found gesture. Dalle Vacche goes on to describe the "discovery" of the character of a pickpocket through a series of tentative "shifts, waverings, uncertainties, resorts to rhetoric, empty-eyed evasions" made in the course of filming; she concludes: "Through 'Michel' [the character], Lassalle [the actor] dis-

35. Less precisely, such systems are sometimes called nonlinear. More precisely, if $\omega$ is a vector of physical observables, and $\eta$ is the state vector of the system, then what the TG2001 evolution engine does is to compute a gradient field $F[\omega,\eta]$ and integrate that field in order to evolve the state vector $\eta$. All variables are implicitly functions of a formal parameter that is not called time.

covers a new self that can only emerge *as the result of an interaction with the camera*."[36]

This observation contains the key relevance to our situation. Setting aside the neorealist essentialization of gesture marked by the language of discovery, and returning to our present situation with these examples in hand, we see a parallel between the responsive technology of the cinematic/directorial machine and the technology of a responsive media space. One does not have to believe that there is some essential gesturing body to be discovered in the experience of a TGarden in order to discover—or better, *construct* and *perform*—a new body from her gesture. Just as Bresson's camera is not a neutral recording agent but the optic end of a complex set of cinematic procedures and expectations that coproduce "Michel," the TGarden's media-synthesis procedures, machinic and mythic, cogenerate bodies with the gestures of the human agents in the space.

Even more interestingly, one does not even necessarily remain a one. In a TGarden, each flesh-body can be dressed with a costume of sparks, say of small LED lights. As people dance illuminated only by the projected video, to a camera they appear as clouds of particles that disassociate and reassociate without boundary. If what constitutes a gesture is determined post facto by some statistical measures like synchrony, then what constitutes a body shifts and shifts again depending on the software processes of observation and sensor-data analysis and on the physical movements of the costumes. Thus, in the TGarden's media-choreography system, the statistics that perform what in more-inflated language could be called computational perception, have no fixed assignment of data stream to body. The software treats the multiple streams jointly and performs sensor-data fusion—a term of art in computer science—in any number of ways. Furthermore, deeper in the network of statistical analysis code, functions can be composed and parameterized to dynamically cluster sensor data so as to variably constitute a synchronic entity. This analytic grouping is contingent upon the thresholds and integrating methods that are in force at the moment. The creators of the system can modify such dynamical behavior by prior design, or leave this to the moment of performance.

Tracing the effects through the air, the light, the software, the projected media, we see how gesture circulates so that it can no longer be considered an entity simply bounded in time and spatio-energetic extent, and stratified by material species from the medium

36. Angela Dalle Vacche, *The Body in the Mirror: Shapes of History in Italian Cinema* (Princeton: Princeton University Press, 1991) pp. 142–143 (emphasis added).

that it perturbs. We could conclude that software sustains responses to gestures and synthesizes responses that in turn *extend* the gesture. Let us see where this thought leads us.

*Process and Response*

An aspect of gesture that I have not surfaced till now is its temporality. As a gesture cascades through a computational system it multiplies into dozens and hundreds of effectively parallel processes, some of which recirculate as humanly perceivable media, others as effects wholly embedded in machine operation. Consequently, we should think of gesture as having not simply a time-index but a *temporal texture*, with multiple dynamics and multiple dimensions. What the costumes, the movement sensors, and the real-time tracking and media-synthesis systems enable is an intertwining of dynamical gestures in a field of subjectivity spanning all the densities of the experience.

Let me turn for a moment from the computational and consider playing the violin. The gestures of the contemporary violinist, partly physical and partly musical, are the residue of five centuries of performance practice sedimented into the bodies of the violinist and the violin. Bowing with a hammered, *martelé* (*martellato*) stroke, the violinist slides the bow across the strings to make short, detached sounds in a definite manner:

> a series of short quick *up* and down strokes at the point of the bow, without allowing the bow to leave the strings. The stick is held firmly and the thumb pressed in the direction of the index finger, as each note is played. The arm should remain quite loose, and care should be taken to give a stronger pressure to the up bow than the down bow, or else the *martelé* will become uneven.[37]

In the family of *staccato* bowing, however, this technique is distinct from *spiccato* bowing in which the violinist lets the bow skip off the string and bounce from the combined tensions of the metal wire and the bow's horsehair. The intentional tensioning of the hand and arm of the violinist parameterizes the physics of the violin. The bounce is carefully conditioned by the hand and arm according to musical inflection and phrasing. TGarden's media synthesis software was designed so that players could "*bow*" through the media in this sense.

Returning to computational media, the TGarden was inspired also by the performance of physical musical instruments. However, the computing of responses to human gesture in "live" performance us-

37. *Grove Dictionary of Music and Musicians*, vol. 5 (New York: St. Martin's Press, 1954), p. 590.

ing current computer architectures and network technologies inevitably encounters problems with latency and the perception of causality. As the horsehair of a bow drags across the wire-wound string on a violin, the friction, pressure, and vibration generate sound at the speed, so to speak, of matter: the violinist hears the sound immediately upon contact. When the response must be computed, however, a computation can in principle take an arbitrary amount of time to compute. In fact, we know from complexity theory that it may be strictly undecidable whether a program runs forever or completes in a finite time. Moreover, networks add a physical indeterminacy to the time it takes for effects to percolate through a web of software on a set of networked computers. Creators of electronic musical instruments know that the delay—the latency—in a system must be quite small, on the order of 1/100th of a second, in order to give the feeling of a tight causal connection between the musician and the sound. (This comes as a shock to designers of conventional structured documents where the dynamics are much coarser, especially in the decade after the introduction of what has been called the World Wide Wait.)

The violin sounding at the speed of matter illustrates how gestures may find completion simultaneously and continuously with their inception. Gesture in such topological media can sustain a "specious concurrency"—what experientially appears as the synthesis and shaping of media simultaneous with the initiating movement.[38] For this reason, I avoid using the term "interaction," which relies on discrete, exclusive utterances and discrete atomic speakers and entails a turn-taking model of communication: A, B, A′, B′, A″ B″, and so forth. Instead, I prefer to use "responsivity" to name that which gives a sense of resonant and palpable embedding in a living world. Gestures in topological media, like those in musical and erotic fields, draw power from their continuous concurrency. Furthermore, a gesture ramifies powerfully when its response, whether on the string of the violin or the body of the lover, emerges coincident with the stroke and nuances the stroke. Notice that we are not concerned here with analyses distinguishing between notation and recording—in either case, we would still be looking at representations after performance. In place of representation, I consider gestures and gesturing as working and workable material.

38. After William James's specious present, in *Principles of Psychology*, ed. F. H. Burkhardt, F. Bowers, and I. K. Skrupskelis (Cambridge, Mass.: Harvard University Press, 1981), p. 573. I am indebted to Steven Meyer for the reference.

## Consequences

Formally, we see two strong consequences of topological, responsive media: dissolved subjective monolithicity, and the possibility of neosemy, the invention of new gestures. We have seen how, under the embodying action of open gesture admitting multiple completions, bodies, objects, and subjects can dissolve and form out of textured fields. We have also seen how the very continuity and kinetic texture of gesture in these open spaces sustain the construction of fresh gesture.

But more is at stake, because technological mediation implies the interpolation of power. As Friedrich Kittler and Martin Heidegger before him have pointed out, technology has always mediated our being's situation. Some forms of mediated creative gesture, however, seem more egregiously and banally commodified than others. In the late 1990s, ColorMeMine, a faux craft ceramics workshop in California, provided preformed clay bowls that saved the customer from practicing the difficult and practically unlearnable craft of throwing clay: the customer paints the glaze on a chosen prefabricated vessel, and the store fires the piece. By interpolating himself or herself into the chain of production, the customer is rewarded with a mass-customized piece of art. Karaoke is another example even more closely related to this domain of performance as industrialized entertainment. I do not deny the pleasure to be had in these contemporary forms of templated performance art, but my question concerns the potential for the interpolation of a calculus of policy that carries normative force. In other words, every place where technology mediates a gesture is also a place in which control can be designed and inserted to interpolate, constrain, or even contradict the impulse of the gesture. Rather than agitating for unmediated Luddite gesture, I am more concerned with the potential nature and mechanisms of the technologies of gesture.

So what is at stake when gesture becomes a computationally mediated commodity? In the robotics laboratory of Michael Peshkin and Edward Colgate at Northwestern University, we glimpse the first industrial application of what can be termed cobotic agency: computer-guided machines whose range of action is controlled by computer, but whose motor force is supplied by the human.[39] The problem with conventional robots, according to Peshkin and colleagues, is

39. See Timothy Lenoir and Sha Xin Wei, "Authorship and Surgery: The Shifting Ontology of the Virtual Surgeon," in *From Energy to Information: Representation in Science and Technology, Art, and Literature,* ed. Bruce Clarke and Linda Dalrymple Henderson (Stanford: Stanford University Press, 2002), pp. 283–308.

that machine muscle plus human error yields a perilous combination—so they proposed the reverse. Imagine how much safer it would be to assemble cars in a factory where a computer constrains the range of a robot winch arm's movement and the human worker provides the necessary (scaled) motive force. With computer-mediated surgery, the stakes and constraints grow higher still, with increased opportunity for implementing policies on where and when and how much to cut at an ever-finer scale via programmable tools. Jean Baudrillard's discussion of how the human application of motor force has been replaced by the application of decision-making[40]—the button replacing the hammer—and Leroi-Gourhan's story about the prosthetic transformation of the human body get a curious twist: it is no longer the machine playing the mule and the human flicking the whip, but the reverse.

*Freedom and Play*

Finally, let us turn to the relation between gesture and freedom. To put it compactly, using Guattari's language, what is at stake as cultural production incorporates new media technologies is the free invention and continuous play of forms of ethico-aesthetic enunciation. Classically, freedom of movement, freedom to improvise, to surprise, even to surprise the designers of a responsive media space, binds to the question of freedom's relation to choice and determinism. However, contrary to the conventional expectation, freedom does not equal choice. Given an increasing number of options, the gesture of selection reduces to the tracing of a decision tree of unbounded extent. Play reduces to choosing among a discrete number of options, which becomes a decision game. But a decision game is quite far removed from the TGarden responsive media space's improvisatory play, which starts with no prearticulated rules of behavior. In particular, a TGarden is not a game. Likewise, a trampoline responds according to its elastic physics and the physics of collision, but does not need rules for goal- and task-oriented metrized play.

On the other hand, a lack of determinism does not yield freedom either. Flusser observed that a scientific account of a mechanism of

40. "The style of such gestural systems always implies the suppression of muscular energy. . . . All these tendencies are mediated practically and historically, at the level of objects, by the fundamental supersession of the gestural system of effort, *by the great shift from a universal gestural system of labour to a universal system of control*" (Jean Baudrillard, *System of Objects,* trans. J. Benedict [London: Verso, 1996], p. 47 [emphasis in original]). And this, according to Baudrillard, has led to an "abstractness of human praxis with respect to objects" (ibid., p. 49); thus, "Man has become less rational than his own objects, which now run ahead of him, so to speak, organizing his surroundings and thus appropriating his actions" (ibid., pp. 50–51).

determination, however fully supplied, fails to distinguish between free movement and conditioned movement:

> The analysis of gestures showed us in which sense "to exist" and "to be free" are synonomous: in the sense of "to signify." A gesture is free, and not a conditioned movement, when it signifies something in an intersubjective relation. To write is a gesture and not a conditioned reflex, because it signifies something for others. And to exist is to make gestures, for example to write. The problem of freedom appears like the problem of signification. I explain a gesture, not by the enumeration of its objective causes, nor by the enumeration of its subjective reasons, but by the deciphering of its significance.[41]

His observation makes use of the same cautionary principle—correlation does not imply causality—that I applied to McNeill's argument for a causal entity prior to both speech and gesture. Here Flusser exemplifies conditioned movement by the autonomic reflex of a finger burned by a candle flame, and opposes that to free gesture, where "free" is used in the sense of free agency. It is not entirely clear what role intentionality plays in this account, but it is telling that neither intentionality nor consciousness appears in Flusser's discussion of free gesture. In fact, he does not need to resort to such notions at all in opposing free to conditioned movement.

What we gather from this is that determinism and freedom are formally independent features: the lack of one does not imply the other. This has far-ranging consequences. While it is true that how a responsive media space works qualifies the experience of the gesture and its completion, there is no essential free-ness or determinism inhering in the computational machinery itself. If we, like Flusser, also seek a nondialectic way to understand freedom, we must set aside cognition, intentionality, decision-making, even meaning and language as prior notions, because appealing to those notions as primitives of a theory obscures more than it would explain.

*Decision Games vs. Play Space*

In the current era, consumer electronic games present interactive systems essentially dependent on the dialectic paradigm of choice,

41. "L'analyse des gestes nous a montré en quel sens 'exister' et 'être libre' sont des synonymes: au sens de 'signifier.' Un geste est libre, et non un mouvement conditionné, quand il signifie quelque chose dans une relation intersubjective. Écrire est un geste et non un réflexe conditionné, parce qu'il signifie quelque chose pour autrui. Et exister c'est faire des gestes, par exemple écrire. Le problème de la liberté se pose comme problème de signification. J'explique un geste, non par l'énumération de ses causes objectives, ni par l'énumération de ses motifs subjectifs, mais par le déchiffrement de sa signification" (Flusser, *Les gestes* [above, n. 11], p. 193). See also ibid., p. 188.

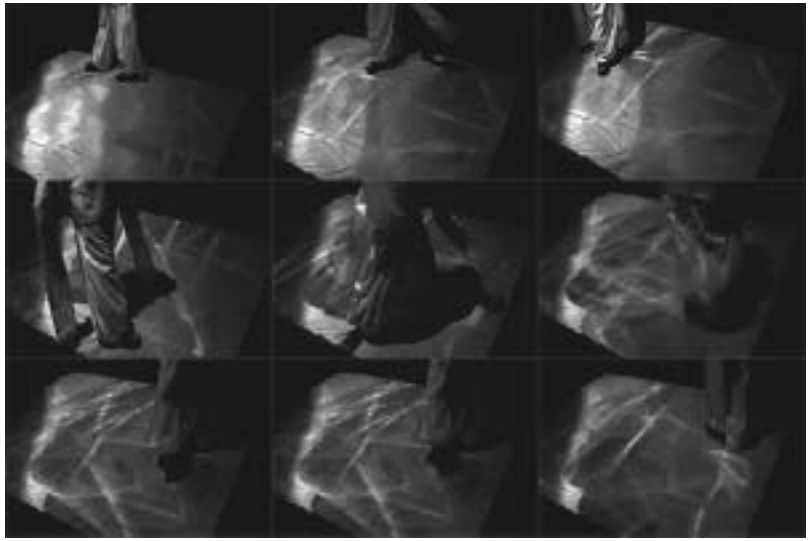

Figure 10. Calligraphic video marked by location, nuanced by gesture. (lab test)

which I have argued is no freedom at all. At every point in the game, you are presented with a finite number of choices; you choose one of them, then the game steps into a new state; you repeat. By contrast, in a responsive media space like a TGarden there is no explicit goal, no task-based activity, no problem to solve. And at the fine machinic scale, there is no parsing of gesture based on an algebraic representation of movement (whether in a notation readable by humans or in a computer model).[42] Instead, it presents a play space for gestures like those of smoking a pipe—gestures of pleasure and of life lived for life, as Flusser put it.

As I have indicated, a computational media space can be made and experienced as a medium that responds like a musical instrument. Supported by the costumes' material affordances designed in

42. Methodological note: Discretization vs. algebraization. I share with Rotman a discontent with algebraic representation, which includes alphabetic systems, lattices, and graphs. It seems that modeling by a lattice or graph omits most of the features in which we are interested. Of course, discretization necessarily occurs in a computer, but that is an approximation, a finitization for this class of machines. To insist that all of experience is binarily encoded would be subject to a reification error. The computational equivalence principle treats all systems found in the "natural world," from brains to weather systems, from the perspective of digital computational procedure—a reduction that is not necessary in our analysis. (For a discussion of the computational equivalence principle, see Wolfram, *New Kind of Science* [above, n. 20], pp. 716–717.)

Figure 11. Dynamic visual projection organism as resultant of summed "gravity" fields from two players.

concert with dynamical computational media, such an instrument of gesture materialized in a topology of aural and visual media, of fabric and bodies, is not an abstract machine of representations but a performance machine, a play space. But what could we do with such a play space?

In his play *The Irresistible Rise of Arturo Ui*, Bertolt Brecht dramatically establishes a clinical and a critical connection between bestiality and fascism by having the Hitler character enact a deconstructive ontogeny of gesture. At the beginning of the play, the actor scampers and scratches like a dog; at the end, his power secured by murder, bribes, and entry into elite society, residues of the dog gestures surface as human tics. This transformation moves with glacial power beneath the narrative threshold and satirically supplies a genetic trace for the Hitler character's gestic relation to Germany-as-Chicago.

What TGarden's designers have sought to achieve is the inversion of such a dramaturgical deconstructive procedure, an inversion that makes possible an open field of continuous variation and improvisation by its nonprofessional inhabitants. (See Figs. 10 and 11.) This field of continuous variation sustains the emergence of expertise, as players revisit the space and learn over time to perform more expertly, much as a calligrapher or a violinist becomes more virtuosic with practice.

In this essay we have a constructed a nuanced understanding of how gesture can be a subjectifying act of creation. Rather than resting content with the claim that gesture is intersubjective signification—a truth, but not a whole truth—we can venture beyond the framework of dematerialized and disembodied semiology. In its place, let me suggest a conception of continuous gesture that can be improvised continuously relative to an open, dense topology of gestures. Freedom consists of improvisation within this continuity and against the resistance of responsive media. This very resistance, material and embodying, allows the gesture to texture itself, to become bodies, and renders it fertile.

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