

The Materiality of Informatics*

by
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Cringe ye, who yet jot "Volkswagon" when the doctor
prompts "automata." The world's changed; no angels
at the top end, now—and you?

Richard Kenney

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EVERY EPOCH HAS BELIEFS, widely accepted by contemporaries, that appear fantastic to later generations. Of such are New Historical studies made—with good reason, for understanding the constellation of practices, metaphors, and presuppositions that underlie apparently bizarre beliefs opens a window onto a culture's ideology. One belief from the present likely to stupefy future generations is the postmodern orthodoxy that the body is primarily, if not entirely, a linguistic and discursive construction. Among the many currents within the culture reinforcing this belief are discourse theory as it is defined and practiced within the humanities, information theory, and information technologies. Although each of these has distinctive reasons for regarding the body as a discursive and informational construction, they collaborate in creating the dematerialization of embodiment that is one of the characteristic features of postmodern ideology.

Yet these sites also operate within material and cultural circumstances that mark their practices and make the claim for the body's discursive construction seem plausible. The body's dematerialization, in other words, depends in complex and highly specific ways upon the material and embodied circumstances that the ideology of dematerialization would obscure. Excavating these connections requires a way of talking about the body responsive to its postmodern construction as discourse/information and yet not trapped within it. Two kinds of distinctions will be central to this project. One is the difference between the body as a cultural construct and experiences of embodiment that individual people within a culture feel and articulate; the other, the difference between inscribing and incorporating practices. Since the body and embodiment, inscription and incorporation are in constant interaction, these distinctions are heuristic rather than absolute. They nevertheless play an important role in understanding the connections between the immateriality of information and the material conditions of its production.

To illustrate how the body is constructed within postmodern discourse as an immaterial informational structure, consider the following claims. "[T]he human body, our body, seems superfluous in its proper expanse, in the complexity and multiplicity of its organs, of its tissue and functions, because today everything is concentrated in the brain and the genetic code, which alone sum up the operational definition of being," Baudrillard writes in *The Ecstasy of Communication* (1988, p. 18). Kroker and Kroker out-Baudrillard Baudrillard in *Body Invaders: Panic Sex in America* (1987), imagining "second-order simulacra" and "floating body parts" that herald the disappearance of the body into a fluid and changing display of signs. "If, today, there can be such an intense fascination with the fate of the body, might this not be because the body no longer exists?" (pp. 20-21) they ask in what they evidently believe is a rhetorical question.

They count the ways the body is disappearing; ideologically, into the signs of fashion; epistemologically, as the Cartesian consciousness (that "grisly and false sense of subjectivity") guaranteeing its existence falls apart; semiotically, into tattoos and floating signs; and technologically, into "ultra refuse" and "hyper-functionality" (Kroker & Kroker, 1987, p. 21). O.B. Hardison (1987) concludes his disappearing act by writing the body into computers. Observing pensively that "No matter what precautions are taken, no matter how lucky the body is, in the end it betrays itself," he imagines "the relation between carbon man and the silicon devices he is creating" to be like "the relation between the caterpillar and the iridescent, winged creature that the caterpillar unconsciously prepares to become" (pp. 20-21). The image of transformation is also central to Hans Moravec's dream of downloading human consciousness into a computer. Moravec, head of Carnegie-Mellon Mobile Robot Laboratory, has launched a research program that he hopes will make the body superfluous, a chrysalis case to be discarded when our transformation into informational bits is complete (Moravec, 1988).

Is it necessary to insist that the body, far from disappearing, remains essential to human life? No human has yet succeeded in living for even a few seconds without a body. How then to account for these ecstatic pronouncements and delirious dreams? I

believe they should be taken as evidence not that the body has disappeared, but that a certain kind of postmodern subjectivity has emerged. This subjectivity is constituted by the crossing of the materiality of informatics with the immateriality of information. By “informatics” (a term appropriated from Donna Haraway, who uses it in a somewhat different sense), I mean the material, technological, economic, and social structures that make the information age possible. Informatics includes the late capitalist mode of flexible accumulation: the hardware and software that have merged telecommunications with computer technology; the patterns of living that emerge from and depend upon access to large data banks and instantaneous transmission of messages; and habits of posture, eye focus, hand motions and neural connections that are reconfiguring the human body in conjunction with information technologies.

The cultural conditions underwriting the body’s disappearance extend beyond explicit discourses about the body to include changing patterns in production, consumption and communication. In *The Condition of Postmodernity*, David Harvey (1989, pp. 121-200) documents the shift from the Fordist regime, characterized by its relative inflexibility and rigidity, to the late capitalist mode of flexible accumulation. To solve the endemic capitalist problem of overproduction and underconsumption, production facilities turn to just-in-time manufacturing, management uses more temporary and contract workers, leveraged buyouts shift the focus from turning out a product to turning over a profit, and service industries specialize in events which are instantly consumable and infinitely repeatable rather than products which accumulate and endure.

Accurate and fast flows of information are essential to keep the cycle spinning. Connected by information networks, the diverse parts of multinational corporations no longer require geographical proximity to function efficiently. “For what is most interesting about the current situation,” Harvey writes, “is the way in which capitalism is becoming ever more tightly organized through dispersal, geographical mobility, and flexible responses in labour markets, labour processes, and consumer markets, all accompanied by hefty doses of institutional, product, and technological innovation” (1989, p. 159). With the centralization of information facilitating and accelerating the uses that can be made of differential variations in locales and labor markets, the material disposition of physical plants and human bodies becomes much more malleable than under the Fordist regime. Increasingly material constraints come to seem like options rather than givens, negotiable indefinitely as long as the information connections are extensive and fast enough. Thus one of the principal effects associated with the regime of flexible accumulation is the decreasing friction of materiality.

In this kind of infrastructure, there is continuing pressure to substitute information for direct experience with material conditions. Shoshana Zuboff’s *In the Age of the Smart Machine* (1988, pp. 315-422) documents the trend through case studies of managerial styles in various corporations. Drawing on Foucault’s analysis on Jeremy Bentham’s Panopticon, Zuboff sees computer technology expanding and deepening the power of surveillance techniques to discipline workers. According to Foucault, the point of the Panopticon is to induce the belief that one is constantly observed, without requiring that such actually be the case. Eventually those who are observed will internalize the Panoptic gaze, disciplining their own actions to bring them into line with the expectations of the observers. Zuboff ranges Foucault’s analysis alongside her study of the Work Force Supervisory System (WFSS) at Metro Tel, a large urban telephone company. The WFSS combined two data bases, tasks to be done and workers available to do them. Each task was assigned a “price”—the amount of time deemed necessary to complete it—and matched with a worker whose efficiency ranking and experience tallied with the task. While on the whole Zuboff interprets her data as supporting Foucault’s analysis, some important new structural features emerge that indicate leaving embodiment out of account also carries a price.

As Metro Tel managers came to rely on the information provided on the computer screen, they reported spending less time on the shop floor interacting with the craftspeople. Diminished were the negotiations between foreman and worker that often included contextual information about the worker’s situation; the foreman was no longer aware of personal factors such as family tragedy or illness that might temporarily affect a worker’s productivity. Also diminished was the give-and-take between worker and foreman that established a mutuality of interest between them. In Zuboff’s analysis, this represents a shift from a consensual relationship of authority to an “informed” relationship in which reified categories of analysis displace personal negotiations. These tendencies, already evident at the first level of management, were exacerbated as one moved up the corporate hierarchy.

Yet the hierarchical structure of corporate management also encouraged new alliances. While each level of management welcomed the enhanced surveillance potential the WFSS bestowed for supervising employees lower on the ladder, each wanted to protect its own prerogatives and performances from scrutiny at the next higher level. On occasion, foremen would collaborate with craftspeople by giving them a password so that they could change the price to bring it into line with actual performance. Second-level managers would collude with foremen to protect them against the scrutiny of third-level managers, and third-level managers would agree among themselves to sabotage efforts by fourth-level managers to get unrestricted access to their data. It is always possible for the higher level to retaliate by changing the programs—for example, for second-level managers to track how often price changes occur and use this as a measure of productivity—but then these changes engender further counterstrategies.

Zuboff’s take on this material is somewhat ambivalent. While she acknowledges that subversion is possible, she also believes that the overall trend of an informed management is toward greater and more effective discipline of the worker. The interviews

she conducted took place within the workplace and focused primarily on managers rather than workers; they thus have certain constraints and presuppositions built into them that may have resulted in an underestimation of the amount and varieties of resistances workers can practice within an informed corporate hierarchy. A different point of view is represented by The Processed World Collective's *Bad Attitude* (1990), a collection of essays, cartoons, Marxist analyses and biographical sketches that advises workers in information industries how to engage in effective subversion and supports them in those efforts. Whether the practices of a particular situation are closer to Zuboff's managerial orientation or The Processed World Collective's guerrilla tactics, the picture that emerges is considerably more complicated than the Panopticon in the abstract. It shows that new surveillance techniques engender new opportunities for subversion and sabotage. Moreover, it makes clear that as the process of reification continues up the corporate ladder, the chances for massive miscalculations increase exponentially as management gets further removed from the realities of the production process. In both cases, the general point holds. When actual situations involving embodied agents are considered, limits appear that are obscured when the Panopticon is considered only as an abstract mechanism. As we shall see, because Foucault's analysis does not recognize these limits, it works to reinscribe as well as challenge the presuppositions of the Panoptic society.

Discourse Theory and the Erasure of Embodiment

Acknowledging that the Panopticon was never built, Foucault (1979) nevertheless argues that it "must not be understood as a dream building; it is the diagram of a mechanism of power reduced to its ideal form; its functioning, abstracted from any obstacle, resistance or friction, must be represented as a pure architectural and optical system; it is in fact a figure of political technology that may and must be detached from any specific use" (p. 205). On the one hand, the abstraction of the Panopticon "beyond any obstacle, resistance or friction" into a system of disciplines dispersed throughout society gives Foucault's analysis its power and universality. On the other hand, it diverts attention away from how actual bodies, in their cultural and physical specificities, impose, incorporate and resist incorporation of the material practices he describes.

It is not coincidental that the Panopticon abstracts power out of the bodies of disciplinarians into a universal, disembodied gaze. On the contrary, it is precisely this move that gives the Panopticon its force, for when the bodies of the disciplinarians seem to disappear into the technology, the limitations of corporeality are hidden. Although the bodies of the disciplined do not disappear in Foucault's account, the specificities of their corporealities fade into the technology as well, becoming a universalized body worked upon in a uniform way by surveillance techniques and practices, Foucault thus participates in as well as deconstructs the Panoptic move of disembodiment. Exposing the assumptions underlying Panoptic society, his analysis also fetishistically reconstructs them by positing a body constituted through discursive formations and material practices that erase the contextual enactments embodiment always entails.

One measure of embodiment's disappearance is the shift in emphasis in Foucault from physical sensation to mental impression. With the Panopticon, the object of discipline shifts from body to mind. "[W]ithout any physical instrument other than architecture and geometry, [the Panopticon] acts directly on individuals; it gives 'power of mind over mind'" (Foucault, 1979, p. 206). Foucault enacts this assumption within his own discourse by implicitly creating a hierarchy of oppression that rates power over mind as more pernicious than power over body. In the early sections of *Discipline and Punish* dealing with corporeal punishment, descriptions of torture are treated as if they are fully commensurate with experiences of being tortured. Thus a system based on corporeal punishment is deemed less coercive than a disciplinary society focused on mental representations. This hierarchical ranking is further reinforced in Foucault by romanticizing corporeal punishment and eliding the particularities of embodied experience. As a result, readers are given the curious impression that it is better to be skinned alive, have hot oil poured in one's wounds, and suffer having limbs ripped off by straining horses than it is to be imprisoned in a modern, clean, sanitary prison. A useful antidote to this view is Elaine Scarry's study of torture in *The Body in Pain: The Making and Unmaking of the World* (1985). Like Foucault, Scarry also uses representations, but her representations are crafted to emphasize that bodily practices have a physical reality which can never be fully assimilated into discourse.

While the absorption of embodiment into discourse imparts interpretive power to Foucault, it also limits his analysis in significant ways. Many commentators have criticized the universality of the Foucaultian body; this universality is a direct result of concentrating on discourse rather than embodiment (Fraser, 1989, pp. 55-66; Poster, 1990, pp. 69-98). Fissuring along lines of class, gender, race, and privilege, embodied practices create heterogeneous spaces even when the discursive formations describing those practices seem uniformly dispersed throughout the society. The assimilation of embodiment into discourse has the additional disadvantage of making it difficult to understand exactly how certain practices spread through a society. Foucault delineates the transformations that occurred when corporeal punishment gave way to surveillance, but the engine driving these changes remains obscure. Focusing on embodiment would help to clarify the mechanisms of change, for it links a changing technological landscape with the instantiated enactments that create feedback loops between materiality and discourse. Building on Foucault's work while going beyond it requires understanding how embodiment moves in conjunction with inscription, technology, and ideology. Attentive to discursive constructions, such an analysis would also examine how embodied humans interact with the material conditions in which they are placed.

At this point, it may be useful to clarify what I mean by embodiment. Embodiment differs from the concept of the body in that the body is always normative relative to some set of criteria. To explore how the body is constructed within Renaissance medical discourse, for example, is to investigate the normative assumptions used to constitute a particular kind of social and discursive concept. Normalization can also take place with someone's particular experiences of embodiment, converting the heterogeneous flux of perception into a reified stable object. In such contemporary scientific visualization technologies as positron emission tomography, for example, embodiment is converted into a body through imaging technologies that create a normalized construct averaged over many data points to give an idealized version of the object in question (Friedhoff & Benzon, 1989, pp. 64-66, 81, 185). In contrast to the body, embodiment is contextual, enwebbed within the specifics of place, time, physiology and culture that together comprise enactment. Embodiment never coincides exactly with "the body," however that normalized concept is understood. Whereas the body is an idealized form that gestures toward a Platonic reality, embodiment is the specific instantiation generated from the noise of difference. Relative to the body, embodiment is other and elsewhere, at once excessive and deficient in its infinite variations, particularities, and abnormalities.

During any given period, experiences of embodiment are in continual interaction with constructions of the body. Consider for example the stress put on the vaginal orgasm during the early part of the twentieth century across a range of cultural sites, from Freudian psychoanalysis to the novels of D.H. Lawrence. Women's experiences of embodiment interacted with this concept in a variety of ways. Some women disciplined their experiences to bring them into line with the concept; others registered their experiences as defective because they were other than the concept; still others were sceptical about the concept because it did not match their experiences. Experiences of embodiment, far from existing apart from culture, are always already imbricated within it. Yet because embodiment is individually articulated, there is also at least an incipient tension between it and hegemonic cultural constructs. Embodiment is thus inherently destabilizing with respect to the body, for at any time this tension can widen into a perceived disparity.

Foucault is not exceptional in focusing on the body rather than embodiment. Most theorists who write on corporeality make the same choice, for theory by its nature seeks to articulate general patterns and overall trends rather than individual instantiations. Theories, like numbers, require a certain level of abstraction and generality to work. A theory that did not generalize would be like the number scheme Borges imagines in "Funes the Memorious." Funes, blessed or cursed by a head injury that enables him to remember every sensation and thought in all its particularity and uniqueness, proposes that each number be assigned a unique, nonsystematic name bearing no relation to the numbers that come before and after it. If embodiment could be articulated separate from the body—an impossibility for several reasons, not least because articulation systematizes and normalizes experiences in the act of naming them—it would be like Funes's numbers, a froth of discrete utterances registering the continuous and infinite play of difference.

Yet there are theories, like this one, that insist abstractly and generally on the importance of the particular. Michel de Certeau (1985), for example, provides a useful corrective to Foucault in pointing to the importance of individual articulations of cultural appropriations. Embodiment is akin to articulation in that it is inherently performative, subject to individual enactments, and therefore always to some extent improvisational. Whereas the body can disappear into information with scarcely a murmur of protest, embodiment cannot, for it is tied to the circumstances of the occasion and the person. As soon as embodiment is acknowledged, the abstractions of the Panopticon disintegrate into the particularities of specific people embedded in specific contexts. Along with these particularities come concomitant strategies for resistances and subversions, excesses and deviations.

It is primarily the body that is naturalized within a culture; embodiment becomes naturalized only secondarily through its interactions with concepts of the body. Consequently, when the theorists uncover the ideological underpinnings of naturalization, they denaturalize the body rather than embodiment. As the example of Foucault illustrates, it is possible to deconstruct the content of the abstraction while still leaving the *mechanism* of abstraction intact. Moving out of the frictionless and disembodied realm of abstraction requires articulating embodiment and the body together. How can this articulation be accomplished without simply absorbing embodiment back into the body?

One possibility is to complicate and enrich the tension between embodiment and the body by juxtaposing it with another binary distinction, inscription and incorporation, that partly converges and partly diverges from it. I envision these two bimodalities acting in complex syncopation with each other, like two sine waves moving at different frequencies and with different periods of repetition. How does the coupling between inscription/incorporation relate to body/embodiment? Like the body, inscription is normalized and abstract, in the sense that it is usually considered as a system of signs operating independently of any particular manifestation. In Foucault's analysis of Linnaeus's biological taxonomies, it does not matter whether the taxonomies were originally printed in Gothic or Roman type; their significance derives from the concepts they express, not from the medium in which they appear. When the concepts are transported from one medium to another, for instance by being cited in Foucault's text and thus printed in a different typeface, the original medium disappears from sight. Moreover, even the awareness that it has disappeared is erased by the implicit assumption that Linnaeus's words have been exactly reproduced. Such writing practices are so common that we do not normally attend to them; I foreground them now to point out that they constitute inscription as a conceptual abstraction rather than an instantiated materiality.

In contrast to inscription is incorporation. An incorporating practice such as a goodbye wave cannot be separated from its

embodied medium, for it exists as such only when it is instantiated in a particular hand making a particular kind of gesture. It is possible, of course, to abstract a sign from the embodied gesture by representing it in a different medium, for example by drawing the outline of a stylized hand on a page with wavy lines indicating motion. In this case, however, the gesture is no longer an incorporating practice. Rather, it has been transformed precisely into an inscription that functions as if it were independent of any particular instantiation.

This line of thought leads to the following homology: as the body is to embodiment, so inscription is to incorporation. Just as embodiment is in constant interplay with the body, so incorporating practices are in constant interplay with inscriptions that abstract them into signs. When the focus is on the body, the particularities of embodiment tend to fade from view; similarly, when the focus is on inscription, the particularities of incorporation tend to fade from view. Conversely, when the focus shifts to embodiment, a specific material experience emerges out of the abstraction of the body, just as the particularities of an incorporating practice emerge from the abstraction of inscription. Embodiment cannot exist without a material structure that always deviates in some measure from its abstract representations; an incorporating practice cannot exist without an embodied creature to enact it, who always deviates in some measure from the norms. One path into further understanding the articulation between embodiment and the body, then, is to explore the connection between inscribing and incorporating practices.

Incorporating Practices and Embodied Knowledge

The distinction between incorporating and inscribing practices, implicit in Merleau-Ponty's *Phenomenology of Perception* (1962, pp. 98-115, 136-147), has been more fully developed by Paul Connerton in *How Societies Remember* (1989). Following Connerton, I mean by an incorporating practice an action which is encoded into bodily memory by repeated performances until it becomes habitual. Learning to type is an incorporating practice, as both Connerton and Merleau-Ponty observe. When we say someone knows how to type, we do not mean that she can cognitively map the location of the keys or that she understands the mechanism producing the marks. Rather, we mean that she has performed certain actions until the keys seem to be extensions of her fingers. Someone can know how to type but not know how to read the words produced, as when a typist reproduces script in a language she does not speak, just as someone can be able to read a typescript without knowing how to type. The body's competencies and skills are distinct from discourse, although in some contexts they can produce discourse or can be read discursively. This is Connerton's point when he writes that the meaning of a bodily practice "cannot be reduced to a sign which exists on a separate 'level' outside the immediate sphere of the body's acts. Habit is a knowledge and a remembering in the hands and in the body; and in the cultivation of habit it is our body which 'understands'" (Connerton, 1989, p. 95).

In distinguishing between inscribing and incorporating practices, I do not mean to imply that incorporating practices are in any sense more "natural," more universal, or less expressive of culture than inscribing practices. The body is enculturated through both kinds of practices. Characteristic ways of sitting, gesturing, walking and moving are culturally specific, just as are characteristic ways of talking and writing. Moreover, culture does not only flow from the environment into the body; it also emanates from the body into the environment. The body produces culture at the same time that culture produces the body. Posture and the extension of limbs in the space around the body, for example, convey to children the gendered ways in which men and women occupy space. These nonverbal lessons are frequently reinforced verbally: "boys don't walk like that" or "girls don't sit with their legs open." It is significant that verbal injunctions often take a negative form, as in these illustrations, for the positive content is much more effectively conveyed through incorporating rather than inscribing practices. It is easy to show someone how to stand but difficult to describe all the nuances of the desired posture in words. Incorporating practices perform the bodily content; inscribing practices correct and modulate the performance. Thus incorporating and inscribing practices work together to create cultural constructs. Gender, the focus of these examples, is produced and maintained not only by gendered languages but also by gendered body practices that serve to discipline and incorporate bodies into the complex significations and performances that constitute gender within a given culture.

Because incorporating practices are always performative and instantiated, they necessarily contain improvisational elements that are context-specific. Postures are generalizable to some extent, but their enactments also depend upon the specifics of the embodied individual—the precise length of limbs and torso, the exact musculature connecting tendon and joint, the sedimented history of body experience shaping muscle tension and strength. Incorporation emerges from the collaboration between the body and embodiment, between the abstract model and the specific contexts in which it is instantiated. In contrast to inscription, which can be transported from context to context once it has been performed, incorporation can never be cut entirely free from its context. As we shall see, the contextual components of incorporation give it qualities that are distinctively different than inscription.

Just as incorporating practices are not necessarily more "natural" than inscribing practices, so embodiment is not more essentialist than the body. Indeed, it is difficult to see what essentialism would mean in the context of embodiment. Essentialism is normative in its impulse, denoting qualities or attributes shared by all human beings. While it is true that all humans share embodiment, embodied experience is dispersed along a spectrum of possibilities. Which possibilities are activated depends on

the contexts of enactment, so that no one position is more essential than any other. For similar reasons, embodiment also does not imply an essentialist self. In *The Embodied Mind: Cognitive Science and Human Experience* (1991). Francisco Varela, Evan Thompson and Eleanor Rosch make this point by juxtaposing Buddhist meditative techniques focusing on experiences of embodiment with recent theories in cognitive science that see the unified self as an illusion created by heterogeneous subsystems. In neither case is a coherent, continuous, essential self necessary or sufficient to explain embodied experience. In Buddhist terms awareness of one's embodied experience testifies strongly against an essential self. The closer one comes to the flux of embodiment, they believe, the more one is aware that the coherent self is a fiction invented out of panic and fear. On this view embodiment subversively undercuts essentialism rather than reinforces it.

If embodiment is not essentialist, it is also not algorithmic. This conclusion has important implications for debates over what difference embodiment makes to thinking and learning. In *What Computers Can't Do* (1979), Hubert Dreyfus argues that many human behaviors cannot be formalized in a heuristic program for a digital computer because they are embodied. Embodiment means for Dreyfus that humans have available to them a different mode of learning, and hence of intellection, than that deriving from cogitation alone. He gives the example of a child learning to move its arm to pick up a cup. The child need not have an analytic understanding of the motor responses and dynamics involved in this action; he need only flail around until he manages to connect. Then to learn the action so that he can perform it at will, he only has to repeat what he did before. At no point does he have to break down the action into analytical components or explicit instructions.

The advantage of this kind of learning is that everything does not need to be specified in advance. Moreover, the learning can be structured into complex relations without the necessity of formal recognition that the relations exist. Drawing from Merleau-Ponty, Polanyi, Piaget and other phenomenologists, Dreyfus delineates three functions characteristic of embodied learning not present in digital programs: an "inner horizon" that consists of a partly determined, partly open context of anticipation; the global character of the anticipation, which relates it to other pertinent contexts in fluid, shifting patterns of connection; and the transferability of such anticipation from one sense modality to another (Dreyfus, 1979, p. 255).

One implication of this view of embodied learning is that humans know much more than they consciously realize they know. Another is that this embodied knowledge may not be completely formalizable, for the openness of the horizon allows for ambiguities and new permutations that cannot be programmed into explicit decision procedures. Moreover, even if one were successful in reducing some area of embodied knowledge to analytical categories and explicit procedures, one has in the process changed the kind of knowledge it is, for the fluid, contextual interconnections that define the open horizon would have solidified into discrete entities and sequential instructions. This is Bourdieu's point (1977) about the largely unnoticed and unacknowledged changes that occur when embodied knowledge is expressed through analytical schema in his discussion of the Kabyle tribe's seasonal rituals. The calendar that the Kabyle enact through improvisational embodied practices is not the same calendar that the anthropologist extracts in schematic form from data provided by informants. Reintroducing context thus not only affects how one describes learning; it also changes the account of what is learned.

Bourdieu's work illustrates how embodied knowledge can be structurally elaborate, conceptually coherent and durably installed, without ever having to be cognitively recognized as such. Through observation and repetition, the child attains "a practical mastery of the classificatory schemes which in no way implies symbolic mastery." By transposing terms of symmetry relations, the child is able to grasp the rationale of what Bourdieu calls the habitus, the "durably installed generative principle of regulated improvisations" (1977, p. 78). The habitus, learned, perpetuated and changed through embodied practices, should not be thought of as a collection of rules but a series of dispositions and inclinations which are at once subject to circumstances and durable enough to pass down through generations. It is conveyed not only through observation of bodily movement but also through the orientation and movement of the body through cultural spaces and temporal rhythms. For the Kabyle, for example, the spatial arrangements of home, village, and field instantiate the dichotomies that serve as generative principles stimulating improvisation within the regulated exchanges defined by the habitus. Living in these spaces and participating in their organization forms the body in characteristic ways, which in turn provides a matrix of permutations for thought and action.

To look at thought in this way is to turn Descartes upside down. The central premise is not that the cogitating mind can be certain only of its ability to be present to itself, but rather that the body exists in space and time and through its interaction with the environment defines the parameters within which the cogitating mind can arrive at its "certainties," which not coincidentally almost never include the fundamental homologies generating the boundaries of thought. What counts as knowledge is also radically revised, for conscious thought becomes as it were the epiphenomenon corresponding to the phenomenal base the body provides. In "Eye and Mind," Merleau-Ponty articulates a similar vision when he writes of the body that is not "a chunk of space or a bundle of functions" but "an intertwining of vision and movement" (1964, pp. 159-192). Whereas the causal thinking that Descartes admired in geometry and sought to emulate in philosophy erases context by abstracting experience into generalized patterns, embodiment creates context by forging connections between instantiated action and environmental conditions. Marking a turn from foundation to flux, embodiment redefines the role and importance of context to human cognition.

When accounts of learning change, so do accounts of cultural transmission. In *How Societies Remember*, Paul Connerton links embodiment with memory. He points out that there is a performative aspect to rituals, commemorative ceremonies and

other bodily practices that an analysis of the content does not grasp. Like performative language, performative rituals must be enacted to take place. A liturgy, for example, “is an ordering of speech acts which occurs when, and only when, these utterances are performed; if there is no performance there is no ritual” (Connerton, 1984, p. 44). Although liturgies are primarily verbal, they are not exclusively so. Gestures and movements accompany the words, in addition to the sense data created by speaking and hearing. Over and above (or better, below) the verbal aspects is the incorporation enacted through sensory responses, motor control, and proprioception. Because these ceremonies are embodied practices, to perform them is always in some sense to accept them, whatever one’s conscious beliefs. “We may suppose the beliefs someone else holds sacred to be merely fantastic,” Connerton writes, “but it can never be a light matter to demand that their actual expression be violated. ... To make patriots insult their flag or to force pagans to receive baptism is to violate them” (1989, p.44).

Bodily practices have this power because they sediment into habitual actions and movements, sinking below conscious awareness. At this level they achieve an inertia that can prove surprisingly resistant to conscious intentions to modify or change them. By their nature, habits do not occupy conscious thought; they are habitual precisely because they are done more or less automatically, as if the knowledge of how to perform the actions resided in one’s fingers or physical mobility rather than one’s mind. This property of the habitual has political implications. When a new regime takes over, they attack old habits vigorously, for this is where the most refractory resistance to change will be met. Bourdieu comments that all societies wishing to make a “new man” approach the task through processes of “deculturation” and “reculturation” focused on bodily practices. Hence revolutionaries place great emphasis “on the seemingly most insignificant details of *dress, bearing, physical and verbal manners*” because “they entrust to [the body] in abbreviated and practical, i.e., mnemonic, form the fundamental principles of the arbitrary content of the culture” (Bourdieu, 1977, p. 94).

Bourdieu somewhat overstates the case when he asserts that “principles embodied in this way are placed beyond the grasp of consciousness and hence cannot be touched by voluntary, deliberate transformation” (1977, p. 94), but he is correct in emphasizing the resistance of such practices to intellection. He also rightly sees the importance of these practices for education and discipline. “The whole trick of pedagogic reason,” he observes, “lies precisely in the way it extorts the essential while seeming to demand the insignificant: in obtaining the respect for form and forms of respect which constitute the most visible and at the same time the best-hidden (because most ‘natural’) manifestation of submission to the established order. ...The concession of *politeness* always contains *political* concessions” (Bourdieu, 1977, pp. 94-95). “Every group,” Connerton writes along similar lines, “will entrust to bodily automatism the values and categories which they are most anxious to conserve. They will know how well the past can be kept in mind by a habitual memory sedimented in the body” (1989, p. 102).

There are, then, four distinguishing characteristics of knowledge gained through incorporating practices that have emerged from the discussion so far. First, incorporated knowledge retains improvisational elements that make it contextual rather than abstract, tied to the circumstances of its instantiation. Second, it is deeply sedimented into the body and highly resistant to change. Third, it is partly screened from conscious view because it is habitual. Fourth, because it is contextual, resistant to change, and obscure to the cogitating mind, it has the power to define the boundaries within which conscious thought takes place. To these four I want to add a fifth. When changes in incorporating practices take place, they are often linked with new technologies that affect how people use their bodies and experience space and time. Formed by technology at the same time it creates technology, embodiment mediates between technology and discourse by creating new experiential frameworks that serve as boundary markers for the creation of corresponding discursive systems. In the feedback loop between technological innovations and discursive practices, incorporation is a crucial link.

Having distinguished between incorporating and inscribing practices. I want to explore the connections between them. To complete the the model I have been constructing, I turn now to Mark Johnson’s *The Body in the Mind* (1987). It is a truism in contemporary theory that discourse writes the body: Johnson illustrates how the body writes discourse. He shows that the body’s orientation in time and space, deriving from such common experiences as walking upright and finding a vertical stance more conducive to mobility than a horizontal position, creates a repository of experiences that are encoded into language through pervasive metaphoric networks. Consider for example metaphors having to do with verticality. We speak of someone being “upright” in a moral or ethical sense, of people “at the top” and of “upscale” lifestyles. Depressing events are a “downer,” in a recession people are “down on their luck,” and entry-level people start at the “bottom of the ladder.” The hierarchical structures expressed and constituted through these metaphors, Johnson argues, have a basis in bodily experience that reinforces and reinscribes their social and linguistic implications. Other common body experiences giving rise to extensive metaphoric networks include in/out, front/back, and contained/uncontained. Such schema Johnson characterizes as prepropositional. The point of his inquiry is to show that these encoded experiences bubble up into language in propositional statements such as “He got high” and in meta-propositional statements having to do with the truth or goodness of propositions, as in “That statement expresses a higher truth.” An obvious implication is that if we had bodies with significantly different physiological structures, for example exoskeletons rather than endoskeletons or unilateral rather than bilateral symmetries, the schema underlying pervasive metaphoric networks would also be radically altered.

It is ironic that Johnson, who launches perhaps the most severe attack on objectivism of the theorists discussed here, reinscribes objectivist presuppositions in positing a universal body unmarked by gender, ethnicity, physical disability, or

culture. Insisting that the body is an important part of the context from which language emerges, he erases the specific contexts provided by embodiment. The consequences of this erasure can be seen in his discussion of a passage from *Men on Rape* in which a law clerk tells why rape in his view is sometimes justified. Johnson shows that the clerk's reasoning is based on a series of interrelated propositions that begin with the idea "physical attraction is a physical force." The clerk constructs a woman's physical attractiveness as an aggression that she practices upon men and to which they sometimes respond with (allegedly retaliatory) violence (Johnson, 1987, pp. 1-12).

In some ways Johnson's analysis is remarkably astute, for it reveals how gendered experiences of embodiment get encoded into implicit propositions. Yet with stunning reticence, he never remarks upon the gender politics so obviously foregrounded by this series of propositions, treating the example as if it were sexually and culturally neutral. More than one graduate student whom I have asked to read Johnson's book has thrown it down in disgust at this point, assuming that any analysis so gender-blind could have nothing significant to say to her. I think this is a mistake, for the general point that embodiment is encoded into language through metaphoric networks is strengthened rather than undercut by insisting on the specificities of physically diverse and differentially marked bodies. Just as the schema would vary for different physiologies, so would they for the different experiences of embodiment created by historically positioned and culturally constructed bodies. From such considerations emerges an enriched appreciation of how inscribing and incorporating practices work together to create the heterogeneous spaces of postmodern technologies and cultures.

Although Johnson does not develop this implication, his analysis suggests that when people begin using their bodies in significantly different ways, either because of technological innovations or other cultural shifts, changing experiences of embodiment bubble up into language, affecting the metaphoric networks at play within the culture. At the same time, discursive constructions affect how bodies move through space and time, influence what technologies are developed, and help to structure the interfaces between bodies and technologies. By concentrating on a period when a new technology comes into being and is diffusing throughout the culture, one should be able to triangulate between incorporation, inscription, and technological materiality to arrive at a fuller description of these feedback loops than discursive analysis alone would yield. To develop such an analysis, I will consider interactions between inscription, incorporation and discourse within the emerging technologies of informatics, specifically word processing and virtual reality.

The Materiality of the Dematerialized Body

One of the commonest ways we interact with the digitalized data bases of information technologies is through our digits. As the technology has advanced from manual to electric typewriters to computer keyboards, the touch needed to produce the inscriptions has grown progressively lighter. At the same time, the material resistance of the text to manipulation has dramatically decreased. To erase an error on a manually typed page, it was necessary to interact physically with the paper. Touch was heavy—my fingers used to ache after pounding away on my old Smith-Corona for a couple of hours—and the resistance of materiality was immediately and physically present. Moreover, the strength of the touch was directly related to the inscription it created. If a keystroke was not quite on center, the corresponding letter came out lighter than its companions. Inscription and incorporation were joined in an arrangement that was visually apparent every time a key lever moved. The proportionality of forces formalized by Newtonian mechanics was learned through the body by habituated motions; hardness of touch equalled darkness of inscription. When such incorporating practices are a part of daily life, it seems reasonable to think of signification as a relationship between word and referent, for a homologous relationship exists between keystroke and letter. One produces the other in direct proportionality.

With word processing, the touch grows lighter and the friction of textuality decreases almost to zero. The smallest keystroke can completely reformat the text, move it to a new location, or erase it altogether. The text seems to have lost its materiality, existing not as pages dotted with erasures but as lights flickering on the screen. The relation between incorporation and inscription, no longer proportional and mechanical, is electronic and exponential. Moreover, in many electronic systems the text is interactive, existing less as a two-dimensional plane than as multiple stacked layers that can be accessed by calling up windows or creating interactive icons through hypertext programming.

These configurations produce and are produced by new theories of signification. "Language is not a code," Lacan (1970, pp. 55, 68) asserted, because he wished to deny any one-to-one correspondence between the signifier and the signified. In word processing, however, language is a code. The relation between assembly and compiler languages is specified by a coding arrangement, as is the relation of the compiler language to the programming commands that the user manipulates. The nonproportionality of touch is achieved by creating coding chains in which the signifier at the upper coding level is precisely linked to the signified at the lower level. Acting like linguistic levers, the coding chains impart enormous power to the lightest touch.

These changes in the material substrate have important implications for such fundamental matters as how signifiers are defined. In much of poststructuralist theory, the material nature of the signifier is considered to be self-evident, for example an ink mark on a page. Electronic media complicate that picture. If we take the signifier to be the flickering light the user sees, it is

internally complex rather than identical with itself, expanding and collapsing like an accordion as the various coding levels are brought into play. Through these multiple transformations something is conserved, but it is not the mechanical energy implicit in a system of levers or the molecular energy of a thermodynamical system. Rather it is the informational structure that emerges from the interplay between pattern and randomness. The immateriality of the text derives from a translation of mechanical leverage into informational patterns that can undergo transformations unthinkable if matter or energy were the primary basis for the systemic exchanges.

What the user learns in her body as she interacts with this system is that signifiers flicker rather than float. The internal complexity of flickering signifiers manifests itself to the user as the ability to mutate, to undergo sudden and dramatic changes in form that would be impossible in materially resistant structures. After pressing a wrong key and seeing her text disappear in an eyeblink, she also learns that informational patterns are interpenetrated with randomness. Connected by her ten digits to these binary digits, she experiences a riptide of feedback that begins to make her body seem as immaterial as the text she manipulates. The feeling is reinforced by all of the other experiences information technologies offer that reduce the friction of distance and materiality nearly to zero. We should not lose sight of the fact, however, that this dematerialization depends upon the material conditions that produce it, from the kinesthetic and neurological interaction of the worker to the keyboard to the larger social and economic changes that writers such as Harvey and Zuboff document.

Language is of course involved as well. At the level of discourse, flickering signifiers interact with such discursive formations as the textual metaphors of genetics, where material structures “express” information, as if they were the articulations of pre-existing genetic words. At the level of grammar, they interact with such prepositional use as “He is into computers,” which implies that the body can flow into and occupy objects or even concepts as if they were spaces—a feat hard to imagine if the body is a material structure but commonsensical if it is an informational pattern. In popular culture, the body’s dematerialization into information and its consequent tendency toward mutation can be seen in films such as Cronenberg’s “The Fly” and “Videodrome,” and in novels such as Tom DeHaven’s *Freaks Amour* and Katherine Dunn’s *Geek Love*.

The erasure of materiality implicit in word processing is carried further with virtual reality. The material effects of this dematerialization can be illustrated by the changes that virtual reality brings about in proprioception. Proprioception, the sense that defines body boundaries and gives us the feeling that we inhabit our bodies, emanates from the inner ear and internal nerve endings. In rare instances, the proprioceptive receptors are damaged through disease or accident. In “The Disembodied Lady,” Oliver Sacks (1990, pp. 43-54) recounts the story of Christina, a woman who lost her proprioception when she suffered a neurological illness. With it went her intuitive ability to control her body. Eventually she learned to sit and walk again, but only through extraordinary concentration on controlling her movements. Describing herself as “pithed,” she felt that her consciousness had been scooped out of her body. She was forced to manipulate it as a puppeteer controls a puppet, by attending to it and creating motion from a spot removed from the body. How strange it is that this highly unusual state, which only a few humans experience, should have been taken as normative by Descartes. Christina, the ultimate Cartesian woman, reveals by contrast how important proprioception is to creating the embodied space within which humans experience the world. For people who have not suffered neurological damage, proprioception creates a link between the body’s extension and habitually used objects. An expert tennis player experiences the racket as an extension of her arm: an experienced typist feels the keys as part of his fingers. The material resistance of these objects to motion is like the resistance of the body itself.

Virtual reality technologies modify the body’s proprioceptive sense at the same time that they extend and reinforce it. As many people now know, virtual reality (VR) is a sophisticated computer technology that puts the body into an intense and direct feedback loop with a simulation, in one version, the user wears a stereovision helmet and a body glove that senses the positions of head and hand. When the user turns her head, the computer adjusts the simulation accordingly so that the scene changes as it would if the user were inside the screen looking around. A representation of the user’s hand appears in the simulation, allowing her to manipulate virtual objects by moving her actual hand. Moreover, in some simulations she can change her position by making certain codified hand movements. Other versions interface VR simulations with exercise equipment so that the user can take a bike ride inside the computer, as it were, enjoying the scenery and action that the simulation provides.

What happens in VR to the feedback loop that proprioception creates between the body and habitually used objects? The hand closes to grasp a simulated bird, and something happens in the user’s visual field as a result of that action. The hand itself, however, has felt none of the material resistance it would if it grasped an actual bird. Proprioceptive sense flows out of the body to meet the artifact, but since there is no material object, it returns in a feedback loop that acts to de-materialize the body. As John Perry Barlow (1990) put it after experiencing VR, “I felt as though my everything had been amputated” (pp. 34-45). I suspect that most users, including myself, find the effects more subtle, but there is no doubt that some de-actualization of the body takes place.

Here is an incorporating practice, then, that interacts in specific material ways with an inscribing practice to create a bodily impression of immateriality. In making this observation, I do not intend to cast VR in the role of cultural villain. Rather than locating the source of immateriality in VR technology, one could equally well argue that this is the kind of technology an ideology of immateriality would encourage. VR is merely one site among many in contemporary culture where the material effects of a predilection toward immateriality can be observed. The predilection catalyzes the technology, and the technology

reifies and extends the predilection. Discursively, the technology interacts with metaphoric networks of in/out and container/contained, making the distinction indicated by the slash less a boundary than a permeable membrane across which subjectivity is diffused. In William Gibson's *Neuromancer*, for example, point of view becomes pov, which is not so much an acronym as a noun that constitutes the character by literalizing his position within the simulation into an entity capable of containing his subjectivity.

Equally significant is the changed relation between inscription and incorporation in VR technology. The implications become clear when VR is compared with cinema. For the viewer accustomed to cinematic conventions, the camera position stands in for her mobility. She interprets a panning movement to be equivalent to turning her head, although in fact she remains stationary. There is thus a disjunction between the conventions of the inscribing practice and the incorporating practices to which they correspond. The disjunction gives bodily actuality to the perception that she is watching a representation, that is to say, an inscription.

In virtual reality, by contrast, turning one's head corresponds to a change in scene. Moreover, there is a slight time lag between head motion and scene adjustment as the computer processes the thousands of calculations required to generate the new scene. The user has the strong impression, therefore, that the proprioceptive sense of having turned her head has *caused* the scene to change, as is indeed the case. When the body has already been partially dematerialized by the ethereality of the virtual reality grasp, the link between proprioception and vision further reinforces the user's sense that the body is immaterial, an informational pattern interacting with the informational patterns on screen. This sense is all the stronger because causation rather than disjunction joins the incorporating and inscribing practices. Whereas cinema is a pre-existing inscription written by someone else that we read in a stationary or motionless position, virtual reality is a potential inscription that we collaborate in writing by moving our bodies as we interact with it. In cinema the emphasis falls on the body as inscribed object, in VR on embodiment as a continuing and instantiated process.

Because VR is an incorporating as well as inscribing practice, it has the power to work directly upon the habitus. In VR, context is broadened beyond the confines of the body and the immediate situation to include aspects of the simulation. To some extent, instantiation happens on both sides of the computer interface. The durably installed patterns of incorporating practices are thus subjected in virtual reality to unusually intense and rapid modification, certainly more so than inscription alone could produce. That this insight is already filtering through the culture is indicated by the sensationalized mutations depicted in the popular film "Lawnmower Man." Although the nascent technology of virtual reality is very far from the way the equipment is represented in the film, the film correctly implies that in VR embodiment and the body will interact through the screen as well as in front of it.

Only because the dematerialization of the body is already considerably advanced within our culture is it possible to argue, as some writers have, that virtual reality will erase the differences created by heterogeneous physical and social contexts of embodiment. When bodies are virtual, these critics argue, what does it matter whether one is embodied in actuality as male or female, white or black, fully functional or disabled? Within the context of the simulation, one can choose the representation in which one wishes to be embodied. I believe that the particularities of embodiment are not so easily left behind. If the cyberpunk novels of Gibson, Rucker, Cadigan and others are any indication, gender will be at least as important in cyberspace as it is on the "real" side of the screen. Since the technology will remain expensive for a long time to come, access will also be an important differentiating factor, re-marking class distinctions in cyberspace by determining who can and cannot afford to enter it and with what equipment. For similar reasons, racial and ethnic distinctions will also be reinscribed rather than left behind by this technology.

Perhaps the one prediction that can safely be made is that the spaces of VR's deployment and the means by which it is interfaced with other inscriptions and incorporations will be highly heterogeneous and fractured. However the arrows of significance emerge, they will not all point in the same direction. As virtual reality makes clear, we cannot afford any longer to regard the body only as a discursive construction if we hope to understand the complex articulations between embodiment and the body, inscription and incorporation, that are producing informatics even as they are being produced by it. The immateriality of the body is one of these articulations; it is not the ground or premise on which an analysis of informatics should be based.

The project of bringing embodiment together with the body to understand cultural formations has special relevance for integrative studies. Whereas literary theory has been especially attentive to discourse, often at the expense of material practices, the social study of science has been especially attentive to material practices, often at the expense of discourse. One of the urgent needs in a field that wants to understand how technology, discourse, and materiality work together is a theoretical framework that will not only give all these elements appropriate weight but will also indicate how they are interconnected through complex feedforward and feedback loops. Of necessity, such a framework will have to be radically interdisciplinary, able to consider both the embodied materiality of particular structures and the abstract representation of discursive systems. Postmodern subjectivity is informed by nothing less.

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Virtual Bodies: Cybernetics, Literature, Information. "The Materiality of Informatics," drawn from this larger work, is intended to create a more flexible framework with which to understand embodiment in the context of virtual reality technologies and texts.

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