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The Virtualization of Art Practice

Body Knowledge and the Engineering Worldview

Simon Penny

When artists engage electronic and particularly digital tools, a negotiation occurs between methodologies of traditional art practice and the value system inherent in the tools themselves. This negotiation is implicit and rarely discussed. The nature of artistic practice, the artistic product, and the consumption of the work are thereby changed and at variance with conventions understood to operate in preelectronic artwork. The goal of this essay is to make explicit some of the characteristics of the value system that structures these new tools and thus the nature of the negotiation that is taking place, on the level of both individual practice and historical trend. The virtualization of artistic practice by the use of simulatory tools implies the eradication of kinesthetic or somatosensory awarenesses and skills. I will argue that a holistic relation to the self (mind/body) is central to traditional artistic practice, but that the philosophical tradition around which the computer is built inherently affirms the Cartesian duality. Contrary to the popular rhetorics of "convergence," a dramatic philosophical collision is occurring because the goals and methods of the discipline of engineering are at odds with traditional artistic methodologies.

Because electronic media art practice is interdisciplinary, so must this essay be. To construct my argument I must touch on issues in diverse fields, from the histories of engineering, computer science, artificial intelligence, and robotics to cognitive science and neurophysiology. I do, however, ultimately draw this material back into a discussion of artistic practice in electronic and digital contexts.

Few artists, and fewer art departments and academies, can have escaped the imperative to reconcile their practice with "the digital." This imperative takes numerous forms, and the responses also run the gamut from Neo-Ludditism to rabid enthusiasm (though each of these extremes is problematic). Institutions face curricular and financial pressures unlike any previously encountered. Teachers face thorny pedagogical issues, and artists must locate their practice within a new technological, and increasingly within a new cultural, context.[1] This imperative is a product of several forces that combine to create the "digital revolution." Digital technology changes at an alarming rate, forcing continuous financial investment and continuous relearning of skills. The rapid changes in digital technology are due not necessarily to user demand, but to the business strategy of built-in obsolescence: this year's model must be superseded for the company that produces it to stay in business. Beyond and below these marketing issues lies a philosophical problematic: the computer, as the (quintessential) product of the discipline of engineering, is premised on certain ways of thinking about the world, which, I will argue, are incompatible with the traditions of the fine arts.

Studio Practice and the Electronic

For a time it was fashionable to preface theoretical writings with a personal anecdote. I offer this story to help anchor in daily practice the concerns elaborated below. In my studio practice I have moved from building relatively simple machines to including increasingly sophisticated analogue and digital electronics. At first the modes of interaction were relatively simple switch systems, but by the mid-1980s they had become complex, with the use of hardware logic for sensor data collection, process timing, and output control. At that point I became aware of three things. First, the most time-consuming part of the work (the control circuitry) was invisible to the viewer. Second, the functioning of this control system was far beyond the sensory range of humans, in both temporal and spatial scale (operating at megahertz speeds performing millions of operations per second using components measured in nanometers). Third, even if the substrates of the chips were rendered visible, the actual events—movements of electrons—are inherently invisible to the human eye. These realizations brought on something of a crisis, throwing into high relief my previously more or less unquestioned aesthetic which was informed by modernist precepts such as "truth to materials" and late-modernist sculptural formalism. These precepts had led me to build work in which the functioning of the work was open to full investigation and could be visually "understood." I realized that this was all very well for cogs and chains and even switches, but impossible and irrelevant in the realm of the electronic. This led to the realization that aesthetic decision making in the electronic must necessarily forgo the comfort of an "authenticity" based on materials and methods: a quintessentially postmodern realization.

The production and consumption of the fine arts, particularly the spatial arts, from dance to sculpture and all in between, are inherently bodily processes, combining vision with somatosensory modes of knowledge. The electronic, digital, informatic realms, on the other hand, are inherently abstract. Not only is the informational substance ephemeralized (digital data or the movement of electrical charges), but so is the mode of comprehension: abstract diagram or keyboard and monitor are modes that exclude the bodily ways of knowing. There is then a crisis at the heart of the much touted "convergence" of the arts and digital media. The elaboration of this crisis is the subject of this paper.

These are crucial issues for those of us who engage technological tools for artistic purposes. As electronic media artists we depend on the products of the discipline of engineering to make our work. Every day we come to new reconciliations between our artistic goals and methods and the requirements and restrictions of the machines we work with. With a little critical distance, we can see that we are reshaping artistic practice to suit a new set of tools. These tools enforce a very different working environment from that of traditional practice.

Transcending the Body via Technology

"I don't share your nostalgia for the body." So spake an attendee at Ars Electronica 1995.[2] The notion that the body is "obsolete" has inexplicably become particularly fashionable in cybercultural circles. This desire to transcend the body via the technology of the day is to my mind not only peculiar, but much less futuristic than contemporary adherents would imagine. The privileging of "mind" over "body," the abstract over the concrete, is a strong continuous thread in Western philosophy, from Christian Neoplatonism to Descartes and beyond. I have previously observed that when William Gibson's cyberpunks proclaimed that "the body is meat" they neglected to notice that their desire for transcendence of the flesh was by no means a novel notion. It is perhaps the most consistent and continuous idea in Western philosophy.[3] The roboticist Hans Moravec has envisioned a future in which we upload our consciousnesses into galactic gas cloud digital databanks and live as immortal disembodied digital entities. But he neglects to observe just how similar this idea is to "going to heaven."[4] The Australian performance artist Stelarc has argued for the need to hollow out and dry out the body, to develop synthetic skin, and generally to reengineer the body to make it amenable to a symbiotic union of technology and biology.[5]

Where and when did the desire to transcend the body become identified with "technology"? What are the implications of this identification of artistic practice with technological tools? The engineering worldview perpetuates Cartesian dualism. The power of the computer in our culture, simultaneously economic and discursive, has made this idea newly current in popular discourse, although it is philosophically anachronistic.

Parts of the ensuing discussion might be found to be affronting to engineers; my critique is levied not at persons but at the accumulated and often implicit ideology of engineering, an ideology with which we are all inoculated. Like many others in the West, I have internalized the scientific method and the engineering worldview and I take part in the practice every day. What I aim to question is the limits of usefulness of its ideology.[6]

The Engineering Worldview

Although science and engineering do not combine to form a homogeneous entity, there are core ideas uniting the scientific method, the logic of industrial production, and capitalism. The first of these ideas, reductivism, allows that phenomena can be usefully studied in isolation from their contexts. This in turn allows that a holistic system can be rationalized into chosen vectors, vectors that maximize productive output, and hence profit, with respect to input: materials, energy, money, and labor. This way of thinking is an "article of faith" for Western culture for very pragmatic reasons: the instrumentalization of this method has led to industrialization, hence to wealth and power in the modern period. The privileging of scientific discourses in our culture is entirely due to this wealth-generating power. Noah Kennedy has argued:

> *In a sense, the mechanical intelligence provided by computers is the quintessential phenomenon of capitalism. To replace human judgment with mechanical judgment—to record and codify the logic by which the rational, profit maximizing decisions are made—manifests the process that distinguishes capitalism: the rationalization and mechanization of productive processes in the pursuit of profit. . . . The modern world has reached a point where industrialization is being pointed squarely at the human intellect.*[7]

These ideas are hallmarks of a nineteenth- and (early)-twentieth-century scientized approach to the world: that mind is separable from body; that it is possible to observe a system without that observation's affecting the system; that it is possible to understand a system by reducing it to its components and studying these components in isolation (that the whole is no more than the sum of its parts); that the behavior of complex systems can be predicted. When these ideas are instrumentalized, they become the ideology of efficient production, what I call the engineering worldview. The values that characterize nineteenth-century engineering ideology find their purest expression in the digital computer. And if the pinnacle of engineering is the computer, then the pinnacle of that pinnacle is artificial intelligence.

In the sixties, the perceived failure of the cybernetic approach of modeling organic systems such as reflexes and neural networks led to the exploration of automated logical systems. The early triumphs of artificial intelligence such as Newell and Simon's General Problem Solver found their success in rigorously confined logical domains, but difficulties arose when attempts were made to generalize these systems to deal with "real-world" problems that have no such bounded domains. Newell and Simon's General Problem Solver stunned the mathematical world by producing a proof for a previously unproven theorem in Russell and Whitehead's *Principia Mathematica*. Computers excelled at logically complex but bounded problems such as playing chess, but they were unable to deal with day-to-day tasks such as crossing the road. It became clear that abstract logical reasoning was easy to automate, in comparison to the underlying substrate of learning we call "common sense," a type of "intelligence" ignored or unacknowledged by the AI community at the time. I would argue that abstract logical reasoning is easy to automate because the discipline of engineering and hence the structure of the computer has its roots in such reasoning. They are isomorphic: like knows like.

Typically, when AI techniques were applied to problems of robot navigation, data were gathered by sensors, and an internal map of the environment of the robot was generated, over which a path was planned. Instructions were then sent to the output devices. As the robot proceeded down this path, the environment was remeasured, the position plotted on the map, and the map corrected if necessary. This method, known as the top-down paradigm, has its roots in Enlightenment abstraction: the "map" is a pure, true, abstract representation, from which decisions about the world are made without recourse to the world. In practice such systems were very slow. It was observed that a cockroach was better at crossing a road than the most powerful computer! Rodney Brooks observed that cockroaches do not "map" and iconoclastically proposed that AI should stand for Artificial Insects. This kind of thinking led to a range of new studies variously known as: bottom-up robotics, alternative AI, complexity theory, artificial life, genetic algorithms, studies of stigmurgy and distributed systems, as well as a new generation of research in neural nets.

The top-down paradigm with its centralization of control inherently perpetuates panoptic models. Furthermore, it exactly replicates and reinforces very traditional dualisms of master and slave, general and soldiers, boss and workers, and more abstractly nature and culture, body and mind, form and content, and hardware and software. Bottom-up theories, on the other hand, seem to oppose vertical authoritarian power structures and endorse horizontal and rhizomatic power structures. This is not to say that new research of the bottom-up camp avoids philosophical pitfalls. A basic premise of artificial life, at least in the words of one of its major proponents, Christopher Langton, is the possibility of separation of the "informational content" of life from its "material substrate." This position is as much premised on the hardware/software dichotomy of computer science as was Watson and Crick's model of DNA. In the 1960s, Watson and Crick explicitly described DNA in computer terms as the genetic "code," comparing the egg cell to a computer tape. Though this is still the dominant paradigm, there is a trend away from reductive and dualistic thinking occurring at every (biological) level. New embryological research indicates that the self-organizing behavior of large molecules provides (at least) a structural armature on which the DNA can do its work. That is, some of the "information" necessary for reproduction and evolution is not in the DNA but elsewhere, integrated into the "material substrate." Alvaro Moreno argues for a "deeply entangled" relationship between explicit genetic information and the implicit self-organizing capacity of organisms.[8]

Out of Engineering

Carolyn Marvin has documented the nineteenth-century valorization of the discipline of engineering and the person of the engineer. She quotes an essay entitled "The Mental and Moral Influence of an Engineering Training":

For some generations . . . [correction of] . . . natural depravity has been left to ministers, lawyers, editors, the mothers of families, to anyone, in fact, but the engineer; and this is where society makes a mistake. The best corrector of human depravity is the engineer. . . . No other man in the world has such *stern and unceasing discipline, and so it comes about that no other man is so safe a moral guide as the engineer, with his passion for the truth and his faculty for thinking straight.*[9]

As the character of the engineer became a model of virtue, so engineering itself came to have enormous discursive power in social and cultural realms. The incursion of the logic of engineering into social, cultural, and educational domains has continued unabated, as various authors, from Theodor Roszak to Manuel De Landa, have noted. Techniques developed for industrial production became "paradigmatic technology" (to use J. D. Bolter's term).[10] When abstracted, they were applied as models and techniques for social control. Browsing a university course catalogue, I was stunned by its similarity to an industrial-parts catalogue. This caused me to reflect on the rather industrial paradigm of liberal-arts education in the United States.[11]

The modern serial-processing computer can be thought of as an assembly line for digital data. In our time, the computer has become a structuring metaphor, the "paradigmatic technology" in a wide range of human activities, including study of the human mind itself, through computationally inspired disciplines such as the style of cognitive science called cognitivism.[12] In a recent commentary on cognitive science, Francisco Varela, Evan Thompson, and Eleanor Rosch discuss the ubiquitous presence of the computer metaphor in cognitive science and the ensuing absence of the body as an object of concern or consideration. They assert that cognitive science has come to an impasse owing to the inability of cognitive scientists to reconcile the results of cognitive science research with their own lived experience. They observe:

[T]he central tool and guiding metaphor of cognitivism is the digital computer . . . a computation is an operation performed or carried out on symbols, that is, on elements that represent what they stand for . . . cognitivism consists in the hypothesis that cognition, human cognition included, is the manipulation of symbols after the fashion of the digital computer. In other words, cognition is mental representation: the mind is thought to operate by manipulating symbols that represent features of the world or represent the world as being a certain way.[13]

The authors propose an alternative approach to the study of cognition that they call enaction, which conceives cognition as an ongoing self-organizing and groundless lived process, based on the idea that "cognition has no ultimate foundation or ground beyond its history of embodiment."[14] This rejection of the possibility of objectivity and simultaneous rejection of the stability of the cognizing subject, arising from the sciences, resonates with the writings of many feminist and poststructuralist theorists.

I have heard specialists of all stripes talk of the mind as "the human information processor" and of the mind "applying algorithms" and "uploading programs." When asked why the brain is thought of as a computer, a psychologist and cognitive scientist responded: "We don't even ask such questions anymore, we know that it is the case." Such metaphors drift quickly into popular language. The danger exists not in the construction of metaphor but when the description is no longer understood as metaphor. How has this metaphor become transmuted into fact? A machine is designed that can process data, the concepts of hardware and software are invented, and various terms such as *memory* are borrowed from human experience to describe behavior of the machine. These newly defined descriptive terms are then folded back on human experience, redefining human behaviors in terms of mechanistic models. It is rather like the drawings in science textbooks of forty years ago, in which the digestive system is depicted as a factory full of conveyor belts and little men in overalls with shovels.

This linguistic sleight of hand is endemic in computer science and serves no useful purpose except to garner large research grants. Terms such as *artificial intelligence* and *knowledge engineering* make inflated claims for the techniques they describe. The case of *memory* is particularly poignant. In borrowing a term from human activity (and subsequently dropping the italics), computer scientists have caused a lot of confusion, especially when the computer paradigm was absorbed into humanistic disciplines, as noted above. Computer "memory" is a digital filing cabinet. Human memory is more than data storage; in fact, it can be argued that it is qualitatively a different phenomenon. The robotics researchers Kerstin Dautenhahn and Thomas Christaller are attempting to denaturalize the computer-science notion of memory by drawing on phenomenological understandings.[15] They note: "[T]here is no memory but the process of remembering. . . . Memories do not consist of static items which are stored and retrieved but they result out of a construction process. . . . The body is the point of reference for all remembering events. . . .[16] Body, time and the concept of self are strongly related."[17]

Because of the power of the computer as the paradigmatic technology in our culture, explanation of human capability in mechanistic terms subjects people to measurement in terms of machine capability; this causes the elision of aspects of personhood that are not functions of the machine. If the measures and definitions for human faculties are modeled on the computer, and the computer is an embodiment of a value system predicated on industrial methods of production, profit, and control via the techniques of efficiency, optimization, and rationalization, then the person has been successfully reduced to an entity only assessable within these criteria: her worth is determined by her productivity, her worth is purely economic. The history of the encroachment of mechanistic logic on the social and cultural realm begins perhaps with the application of machine-divided time to the social order. The moment when it became "normal" to divide time into parcels with assigned tasks was the beginning of time and motion studies and "human factors" engineering.[18]

To differing degrees, we internalize and subject ourselves to the regime of the engineering worldview. We are socialized to divide our days and years into units of time for specific tasks. I measure myself in terms of tasks achieved per unit time. I subject myself to a rigorous discipline of efficiency and optimization.

Clever Meat

I want to argue now for a seemingly absurd proposition: that "mind" does not exist, that "mind" is nothing but a linguistic construction, a concept. The assumption of the existence of something called "mind" has led to the building of an entire conceptual and linguistic edifice. To argue for the nonexistence of mind is an elusive task, not because mind does exist, but because the mind/body split is fully installed in our language. It is difficult even to discuss this issue without resorting to concatenated neologisms such as the "lived body," "mind/body," "think/know," or "being in the world." The necessity for such concatenations demonstrates precisely how the terms *mind, body,* and so forth are entirely inscribed within, and instantly imply, a specific argument.

We should privilege neither the mind nor the body. This would be to perpetuate a dualistic model. To argue against dualism, to propose alteration to the hierarchical relationship of mind and body, creates a philosophical impasse. It is nigh impossible in Western philosophical discourse to discuss "being" in a way that does not assume this duality and hierarchy, because the dominant streams of that discourse are predicated on dualism and privilege the abstract and transcendent over the embodied and concrete.

Long before the era of European transoceanic exploration, Polynesians in wooden canoes were successfully navigating vast distances between the tiny islands that dot the Pacific. It is said that they could sense, by the effect of the ocean swell on their canoes and hence on their bodies, the location of islands over the horizon. This is not the kind of thinking valorized in the Western intellectual tradition, this was not calculation or deduction, they certainly had no sextant, compass, or chronometer. It is a kind of intelligence inseparable from the body. Hubert Dreyfus argued many years ago that the fault at the root of what he called "Good Old Fashioned Artificial Intelligence" is that we understand the world by virtue of having bodies and a machine without a body would never understand the world the way we do.[19] If Dreyfus maintained that we have a human mind by virtue of having a human body, I want to argue more radically that any attempt to separate mind from body is flawed and that the presumed location of the mind in the brain is inaccurate.

Why do we believe that consciousness is located exclusively in the brain, when, contrarily, we put so much faith in "gut feelings"? Why do we describe some responses as "visceral"? Why do ancient Indian yogic and Chinese martial traditions locate the center of will in the belly? We believe that we think with our brains, because we have been taught that this is the case. What if we believed otherwise? How differently would we live our lives? I want in all seriousness to argue that I "know" with my arms and with my stomach. To maintain that the activity we call "knowing" is isolated to a subsection of the body is folly. Why am I pursuing this line of thought? Because first, the redefinition of human capability in terms of the computer resoundingly reinforces the separation of mind and body. And second, because dance, sculpture, painting, and the variety of other fine and performing arts are premised on bodily training, bodily knowledge that implicitly contradicts the mind/body duality.

It has been observed that in certain manual activities of high skill, such as playing the violin, the action is so fast that the nerve signals could not travel up the arm, into the spine and brain, and back again. Motor "decisions" have been shown, not to pass through the brain, but to remain in the limb. A neural closed circuit: the hand is "thinking" by itself. Sten Grillner has proven, at least in the case of a simple fish, that the muscle coordination that results in locomotion arises, not in the brain proper, but entirely in the spinal cord and the adjacent muscles. He notes: "Some mammals (such as the common laboratory rat) can have their entire forebrain excised and are still able to walk, run and even maintain their balance to some extent."[20]

Recent neurological research has shown that the human stomach is neurally far more complex than had been supposed.[21] It is feasible that the stomach might make some decisions "by itself." If the stomach is thinking, then why not the liver and the kidney? And if the arm can function as a neural closed circuit, then perhaps the organs are chatting among themselves. This kind of bodily anarchy is antithetical to the conventional notion of the brain's "controlling" the body and to the top-down model of panoptic control common to the engineering-inspired disciplines.

Early in embryogenesis, a formation called the "neural crest" splits. Half forms the brain and the spinal cord. The other half becomes the nervous system of the gut. It was presumed in medical science, under the strong influence of Cartesian thought, that the gut, like the rest of the body, was a kind of meat puppet, a slave of the master brain. The model of the body "controlled" by the brain and the model of an authoritarian state thus reinforce one another. It transpires that the gut has over one hundred million neurons (more than the spinal cord). The entire intestine is sheathed in two concentric sleeves of neural tissue, isolated with an equivalent of the blood/brain barrier.[22] Just exactly what the gut is thinking we do not quite know, but if the gut were wired to a PET scan machine, I believe we would find that the gut partook in consciousness, or the neural activity from which it arises.

The revelations of recent neurophysiology leave no doubt that the multiple organs of the brain interpret sense data, formulate concepts, and leave traces from which memories are reconstructed, but this does not mean that we must necessarily adopt a position in which the "body" is separate, secondary, and subordinate to the "brain." Antonio Damasio has argued that the conditions that we consciously interpret as emotions, for instance, are generated in the body proper, and the brain actually has to check to determine what emotion is currently being "embodied."[23] Here Damasio reveals the degree to which he (unconsciously?) adheres to the conventional wisdom: to say "the brain interprets messages" is just one way of conceptualizing the process, which puts the brain "in control."[24] Why could it not be: "the body tells the brain . . . "?

The engineering worldview, via the computer as a paradigmatic technology, perpetuates a dualistic model with an explicit hierarchy. Reductivist mechanistic models are, via the engineering worldview, inappropriately applied to the bodies and lives of people. Contrarily, consciousness (or what gives rise to it) is "emergent," is a physiologically distributed bodily thing, and arises from the interdependence of parts in a decentralized system. If this is the case, then the basic premise of cognitivism—that the brain, consciousness, and so on can be understood using the analogy of a computer—is flawed. To apply a mechanistic, reductive model to consciousness is to imply that consciousness does not exist, because consciousness is not amenable to reductive analysis.

Simulation and the Demise of Body-Knowledge

If all traces of humanity were destroyed except for a computer shop, visiting Martian archaeologists would probably determine that humans were monocular and had one hand with twenty-nine digits on it.[25] All the remaining body senses and capabilities are irrelevant to the computer interface. The interface ignores ways of knowing that are not compatible with it; the interface is a filter that rejects these aspects of sentience. By defining intelligence in terms of the capabilities of the computer, the (bodily) intelligence, of the painter, for instance, is lost. One of the least remarked aspects of the computer revolution is the way that the development of software simulation has reduced a great variety of various bodily activities into one. This process, however, is in many ways enabling: we can prepare a publication, from writing text to typography, image placement, and page layout at the same desk. The downside of this process is that it induces a bodily monoculture; it destroys cognitive diversity, the complex ecology of body-knowledge. To extend the ecological/pharmacological metaphor: In the same way that pharmaceutical companies have suddenly (and rather cynically) become conservationists, we may be killing off diverse body-knowledges before we know what they are good for. The Japanese habit of making great craftsmen and artisans "living national treasures" may make more than sentimental sense.

The increase in simulation of bodily activities that result in a depletion of the difficult-to-formalize "intelligences of the body" making up the traditional "skill-base" (as opposed to knowledge-base) of the visual arts is a problem. The traditional artistic skill-base is in danger of being "disappeared" in the race to total simulation. Previously, one learned a set of bodily behaviors to use a machine lathe, another set of activities to set type, another to paint a picture, and another to write. All these activities are now achieved by tapping a keyboard while staring at a video screen at close range.[26]

When I teach a painting program to a student who is an experienced painter, a large part of the meaning in the simulated watercolor mark is related to the physical experience of making such a mark with water-based pigment in a brush on paper. But if the student has never learned to make such a mark, the meaning of the mark is entirely different because it signifies no act. To put it another way: if digital tools simulate analogue procedures, can the basic concepts be understood without practice on such tools? Does a chalk texture mean anything without the experience of using chalk on paper?[27]

Not simply is the range of body-knowledge (body-intelligence) being vastly limited (the body is being deskilled), but the process that links conceptualization to physical realization is destroyed. Manipulation of abstract, symbolic quantities is premised on bodily, physiological experience. Why do we call a high note "high"? Could it be because when we sing a high note the physiological experience is in the head, as opposed to the throat or chest? German psychologists have observed that children who cannot walk backwards cannot subtract. Mark Johnson argues: "In considering abstract mathematical properties (such as 'equality of magnitudes') we sometimes forget the mundane bases in experience which are both necessary for comprehending those abstractions and from which the abstractions have developed. . . . Balance, therefore, appears to be the bodily basis of the mathematical notion of equivalence."[28] As Dreyfus argued, we have a human mind by virtue of having a human body. Here my argument takes an ironic turn, for if balance implies two sides, then in its very bilaterality the body embodies dualism.

Among young children, continuous use of computers, video games, and TV seems to impair the development of basic common sense and motor skills. Certain German insurance companies now sponsor summer schools in which children are "taught" that open flame and red-hot things can cause pain and burns, that you can fall off a bicycle and it hurts, etc.[29] One assumes that the motivation of these companies is not entirely philanthropic, that it saves money to help children avoid simple accidents. This *erosion* of common sense by computer use is a curious mirror of the common-sense problem that defined the limitations of artificial intelligence.[30]

Prosthetic Bondage and Mechanistic Mimesis

Freedom and *liberation* are catch-phrases of cyberrhetoric, but what price do we pay for the liberty of the virtual? Bondage of the physical![31] To make conquering strides across cyberspace, we sit, neck cramped, arms locked, tapping a keyboard, our vision fixed on a small plane twenty inches ahead. As the image becomes more mobile (VR), the viewer becomes less mobile. Held in a bondage of straps and cables, the question "Are you a man or a mouse?" acquires new meaning. In engaging the computer as an artistic tool, the artist must consider the potential conflict of interests between the value systems reified in the architecture of the machine and the logic of the software, and the interests of artistic practice. The very existence of artistic practice with the computer must be seen in the context of these ideas as a kind of intervention, which brings into question issues such as those I have been discussing: the conflict of worldviews inherent in digital art practice, the demise of bodily knowledge, and related matters.

Digital media artists are continually reminded of the fact that when making digital artworks we are building virtual machines. Any machine (soft or hard) is a mechanistic approximation of a narrow and codified aspect of human behavior. On a day-to-day level, the task that confronts us is how to shoehorn the kind of cognitive fluidity we enjoy in our interaction with the world into the proscribed and proscriptive language of the machine. This dilemma is no different whether writing code or building a washing machine. The computer is as pedantic and rule-bound as any other mechanical contrivance. Tasks that are simple and open to variation for a person must be specified and constrained when embodied in a machine.

All machines are contrived according to mechanistic codifications of specific task domains which optimize a particular function. A chainsaw cuts wood fast, but is useless for anything else. Cognitive prosthetics such as robot vision systems, unlike human vision, are, to a greater or lesser extent, task specific. Computer programs are virtual machines; indeed they are sometimes referred to as "engines" in the computer science community. The same compartmentalizing reductive process is at work. Such a method can never reproduce the holism of body experience; it will remain an accumulation of parts. By contrast, certain human activities, among them the production and consumption of art, integrate human faculties in a way that resists reductive compartmentalization.[32]

Machines, hard or soft, are codifications of solutions to problems. Often the sorts of problems artists deal with are as yet uncodified, or are uncodifiable. I heard an architect observe that although CAD systems allow architectural design projects to be completed more quickly, they reduce the possible range of variation. The same may be said of any software package. Software contains packaged solutions to predefined problems. The designer of the package deems which particular problems will be supplied with packaged solutions. These choices may be made because certain processes are computationally easy, rather than because they fulfill the actual needs of artists. The degree to which these chosen solutions and problems are useful to artists is entirely dependent on the degree to which the designer of the package understands artistic generative process. Even then, use of such packages presumes that artistic process can be defined and reduced to deductive problem-solving procedures.

In 1990 Marvin Minsky made some remarks that for me epitomize this dilemma: he proposed that we should "go beyond these VR instruments and implant a little computer in the brain and send signals back and forth from it, which would give us the ability to extend our motivation and the signals inside ourselves to cause things to happen in the outside world." Although this sentiment is a familiar one in technological discourse, it is nonetheless peculiar. I thought that was why we have arms and legs and eyes and ears. Minsky went on to say of this implant idea: "Maybe most of us who are not artists could be artists if we could express our subconscious wants."[33] In this expostulation, Minsky simplistically conflates the surrealists' aestheticization of the subconscious with the engineering inspired dualistic project of the rationalization of the body. It is interesting to learn from him that art making is simply a matter of subconscious self-expression, like some sort of mucous secretion, without the intervention of either skill or intellect. Seemingly (according to the perspective of traditional artificial intelligence) the complex bodily practices and sensibilities that define art practice can be easily dismissed as insignificant motor skills, "hardware problems." Our "subconscious wants," once encoded as digital data, could be realized by some mechanical prosthetic, and this, according to Minsky, would result in art! (I doubt if Minsky would allow that a similar implant would enable us to be artificial intelligence experts.)

Conclusion: Negotiating Engineering and Art

Simplistic rhetoric and obfuscating arguments regarding computers and artistic practice abound in computer industry and cybercultural circles. What I hope to have achieved in this paper is to make complex some of that oversimplification by introducing theoretical and historical arguments.

The digital computer is constituted by the ideology of the discipline from which it arose. This ideology, which I call the engineering worldview, is quintessentially reductive and deterministic. Through engineering and related disciplines, this ideology has been consistently and inappropriately applied to the bodies and lives of people. Characteristics of this ideology include the reification of a hierarchical and dualistic relation of mind and body and the insistent imposition of mechanistic models on non-mechanistic scenarios.

Use of the digital computer in art practice and art pedagogy now slams this ideology into artistic methodologies, which had previously maintained an immunity to that way of relating to the world. Artistic skills and methods are distributed bodily phenomena and inherently refute reductive approaches to questions of intelligence and consciousness. The use of computers in art practice is not a convergence but a battleground. Art working becomes ephemeralized and the connection to bodily action is broken.[34]

The computer embodies the value system of the engineering worldview and the computer is powerfully effective at promulgating those values across culture. Meantime basic premises of the scientific method and the engineering worldview are being challenged from many quarters. If the traditional intelligences of artistic practice are worth preserving, artists must develop a sophisticated understanding of the nature of their practice with respect to digital tools.

Notes

At various stages of its development, the antecedents of this paper have been presented at the 24th Southern Graphics Conference (keynote), University of West Virginia, Morgantown, March 1996; Ars Electronica 96, Linz, Austria, September 1996; the Center for 20th-Century Studies, University of Wisconsin, Milwaukee (in association with the Department of Art, UWM Leyton Lecture Series), November 1996; and Cranbrook Academy (November 1996). I am grateful to the organizers of those events for the opportunity to present my ideas and for the feedback I received.

1. See "Guidelines for Faculty Teaching in Computer-Based Media in Fine Art and Design" (unanimously adopted by the CAA Board of Directors, October 21, 1995), *CAA News* 21, no. 4 (July-August 1996).

2. The speaker was McKenzie Wark, in response to a paper by Steven Kurtz of Critical Art Ensemble at Ars Electronica 95, Linz, Austria (personal notes).

3. See my "Virtual Reality as the End of the Enlightenment Project," in *Culture on the Brink: The Ideologies of Technology*, ed. Gretchen Bender and Timothy Druckrey (Seattle: Bay Press, 1994), 231–49.

4. In the history of engineering, as in the history of Christianity, the vast majority of actors have been male. Recent research into the lives of female medieval mystics indicates that their mystical experiences, unlike those of their male counterparts, were firmly embodied. Simone de Beauvoir argued that masculine culture "identifies women with the sphere of the body while reserving for men the privilege

of disembodiment, a non-corporeal identity." Quoted in Neil Smith, "Homeless/Global: Scaling Places," in *Mapping the Futures: Local Cultures, Global Changes*, ed. Jon Bird et al. (London: Routledge, 1993). Little wonder that enthusiasts for the prospect of the virtual body seem almost exclusively to be male.

5. See, for example, Stelarc, "Redesigning the Human Body," Stanford Conference on Design, July 1983; Stelarc, "Beyond the Body: Amplified Body, Laser Eyes, and Third Hand" (NMA #6, 1986); Stelarc, "Prosthetics, Robotics, and Remote Existence: Post-Evolutionary Strategies," statement for Second International Symposium on Electronic Art, Groningen, 1990.

6. Because the issues I am attempting to discuss are the products of a new sociocultural technological complex, conventional disciplinary approaches are inadequate. My quintessentially interdisciplinary approach is to examine "engineering" with the specula of literary and critical theory and artistic practice. This exercise is itself reflexive; it also allows me a perspective from which to view artistic practice, "from the outside." The best argument I can make for interdisciplinary practice is that a viewpoint from outside a discipline can render starkly visible aspects of a discipline that remain invisible for insiders. Of course one is seldom thanked for making such observations. Disciplines are not quite as permanent as they might appear, housed in institutional buildings. Cultural studies and women's studies are two among numerous examples of new "disciplines"; cognitive science is an example of a "discipline" that seems to be breaking apart.

7. Noah Kennedy, *The Industrialization of Intelligence: Mind and Machine in the Modern Age* (London: Unwin Hyman, 1989), 6.

8. See Alvaro Moreno, Arantza Etxeberria, and Jon Umerez, "Universality without Matter?," *Artificial Life IV* (Cambridge, Mass.: MIT Press, 1994).

9. Quoted in Carolyn Marvin, *When Old Technologies Were New* (Oxford: Oxford University Press, 1988), 32.

10. See J. D. Bolter, *Turing's Man* (Raleigh: North Carolina University Press, 1984).

11. This line of reasoning led me to consider the process of a liberal-arts education in these terms. Raw material (the student) is received and tested. If adequate, this material is subjected to a series of numbered processes in a certain order. At the end of each process, the raw material is tested to see if the process was successful. If so, it moves to the next process. If not, it is either reprocessed or scrapped. Certain processes are only effective if other processes have previously occurred. These processes are modular; they can be arranged in different combinations to produce different products, a pickup or a coupe, a psychologist or a dancer. The efficiency of the "factory" can be measured in terms of degrees produced per dollar input.

12. This more reasonably should be called "computationalism," in the same way that artificial intelligence should more realistically be called automated reasoning, etc.

13. Francisco J. Varela, Evan Thompson, and Eleanor Rosch, *Embodied Mind: Cognitive Science and Human Experience* (Cambridge, Mass.: MIT Press, 1993), 7–8.

14. Ibid., xx. The authors assert, the work of Merleau-Ponty, Heidegger, Husserl, and Nietzsche notwithstanding, that the Western philosophical tradition is largely bereft of tools to deal with the issue of the insubstantial nature of the self. They draw attention to a long tradition of experientially based philosophy of cognition in certain aspects of Buddhist thought (the Madhyamika tradition), which has been developed and refined for many centuries, and recommend it as the basis for a new "embodied" cognitive science.

15. This view of memory is isomorphic, with the recent rethinking of the role of the viewer with respect to an artwork or media phenomenon. The viewer has been allowed an active, constructive, creative, even subversive role. Michael Baxandall makes a similar argument concerning the nature of "influence" in art history: "'Influence' is a curse of art criticism primarily because of its wrong-headed grammatical prejudice about who is the agent and who is the patient; it seems to reverse the active/passive relation which the historical actor experiences and the inferential beholder will want to take into account." Michael Baxandall, *Patterns of Intention* (New Haven, Conn.: Yale University Press, 1985), 58–59. In each case the same paradigm deprives the subject of its agency in the moment, in effect depriving the subject of historical agency, as all truth is locked in the past. These examples suggest that this paradigm might be as covertly ubiquitous as it is pernicious.

16. In 1976 I visited a sculpture exhibition that included a table and chairs at twice their normal scale. The chair seats were about four feet off the ground, and the table, about six feet. The effect of climbing onto the chair was resounding for me. Sitting with my legs dangling, tabletop at chest level, I experienced a cascade of childhood memories. These memories were triggered by a relationship of scale I had not experienced since I was small.

17. Kerstin Dautenhahn and Thomas Christaller, "Remembering Rehearsing and Empathy," GMD Working Paper 956, Sankt Augustin, Germany, 8.

18. For a longer discussion of "time-and-motion" studies in the industrial and postindustrial periods, see Lev Manovich, "The Labor of Perception," in *Clicking In: Hot Links to a Digital Culture*, ed. Lynn Hershman-Leeson (Seattle: Bay Press, 1996).

19. Hubert Dreyfus, *What Computers Still Can't Do* (Cambridge, Mass.: MIT Press, 1992), first published in 1972 as *What Computers Can't Do*.

20. Sten Grillner, "Neural Networks for Vertebrate Locomotion," *Scientific American*, January 1996, 64.

21. Research by Dr. Terrence Powley et al., at Purdue University, reported in *Discover*, May 1995, 26.

22. See "Complex and Hidden Brain in the Gut," *New York Times*, January 23, 1996, B5.

23. Antonio Damasio, *Descartes' Error: Emotion, Reason, and the Human Brain* (New York: Avon Books, 1995).

24. Such reality checks are of course not conscious. And indeed, it has been demonstrated that the point at which a decision to make an action becomes conscious (for instance, I decide to pick up the glass), the mental event is already half over.

25. This story was related by Bill Buxton in his keynote address to the 1988 International Symposium on Electronic Art (personal notes).

26. If one held a competition to design the worst technological interface for the production of painting and drawing, I doubt anyone could come up with a worse one than the keyboard and monitor.

27. One may argue that some digital tools simulate analogue procedure, whereas some do not, but I would counter that all digital techniques are based on predigital techniques: where else can they have come from? A Baudrillardian might say: "Why worry, it is nostalgic to imagine that signifiers are still attached to their referents, to believe this is essentialist, to yearn for the condition of authenticity." Yet this argument is unsatisfyingly abstract. At issue is the relationship between embodiment and "mind." To believe that connection of signifiers to referents is old fashioned is to endorse the Cartesian duality, which induces the bodily dislocation of the computer and its use. The computer dislocates the body precisely because it denies its relevance, in the very same way that Descartes wished to be rid of the body.

28. Mark Johnson, *The Body in the Mind* (Chicago: University of Chicago Press, 1987), 98. This quotation is particularly thought-provoking because I had begun to wonder, independently, whether my dyslexia was related to the sense of disorientation I feel in the face of abstract mathematical arguments for which inverse and reciprocal relationships are key.

29. Helen Michaelson, Media Museum, Zentrum für Kunst und Mediatechnologie, Karlsruhe. Interview, personal notes.

30. Several years ago I was speaking at a symposium. After my talk a woman related this story to me: Her daughter was beginning to learn to write. She wrote, determined that she had made a mistake, and searched in vain for the *Delete* button on her pad of paper! She was extremely upset when the "bad" letter did not immediately disappear. Likewise, my students seem to be so used to their computers that when they conceptualize an idea, they assume it will materialize by itself, as if they had pressed *Print*.

31. This condition is part of a historical progression. In the cinema, while taking virtual journeys, the body must remain still and silent. The subject who attempts to capture the world with the perspectival grid is monocular, pinned through his open eye by the cone of vision.

32. Whether we are examining artificial life or the building of digital prosthetics, the most interesting aspect of this desire to simulate life within the machine is the fact that this desire exists and is so persistent. The desire for the "mechanical bride" is as consistent a drive in the West as is the desire to be rid of the body! See my essay "In Pursuit of the Living Machine," *Scientific American*, September 1995, 216, and "Anthropomorphism as a Cultural Virus," SISEA proceedings (Groningen, 1990).

33. Marvin Minsky, in an address given at Ars Electronica 90, quoted by Catherine Richards, "Virtual Bodies," *Public 11* (Toronto: Throughtput, 1995).

34. It is surprising to observe that this trend to ephemeralization began in the visual arts before computers were readily available. See my argument concerning conceptual art as cultural software in "Consumer Culture and the Technological Imperative," Simon Penny, in *Critical Issues in Electronic Media*, ed. Penny (Albany: State University of New York Press, 1995).

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