Trying to be Calm:
Ubiquity, Cognitivism and Embodiment

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Abstract

Mark Weiser and John Seely Brown proposed the notion of a 'calm' backgrounded technology as a paradigm to counter the laborious in-your-faceness of '90s computer systems and the techno-fetishism exemplified by mid 90's Virtual Reality (Weiser and Seely Brown, 1995). This paper observes discursive and technological transitions between the 'decade of virtuality' (1990s) and the decade of ubiquity (2000-09). The cognitivist paradigm of the 'brain in a vat' is seen as informing notions of computation in the early 90s. This paper notes the increased importance of discourses of embodiment over that 20 year period, and specifically the contributions of media artists and 'post-cognitive' cognitive science. It is argued that (the completion of) a wholesale paradigm shift to embodied, performative perspective is required in order to adequately address theoretical and design challenges of ubiquitous technology.

After virtuality

I have argued elsewhere that the discourses of technological virtuality during the 1990s were in part the result of the effects of an incomplete technology. The transition from the period of virtuality to the period of ubiquity was a result of the maturation of interface technologies missing from the technological palette of the 90s. In the interim, a variety of technologies linking the dataworld with the lived physical world have emerged. Small and large scale sensing and tracking technologies such as MEMS accelerometers, machine vision, laserscanners, GPS, RFID, and mobile communications technologies have been developed and deployed. This has had the effect of nesting the 'virtual' back into the lived physical world. This belated integration of data with the world has caused 'the Virtual' to evaporate. The Virtual has become doubly virtual, revealing it to be a panic around an explosive and messy technological transition period. [1]

Over the same period, as recognition of the shortcomings of the cognitivist paradigm became more widespread, new modes of inquiry in cognitive science, AI and robotics emerged, all loosely related to post AI 'artificial life' approaches. Human interaction with the world and with technology, was addressed more intensively – as is evidenced by the rapid expansion of HCI, CSCW and related areas of research. Cognitive Science and HCI became increasingly interdisciplinary as psychologists, anthropologists and sociologists became involved. New modes of cognitive science emerged to grapple with the embodied, situated and social dimensions of cognition : the Enactive Cognition of Varela, Thompson and Rosch, the Situated Cognition of Lucy Suchman, and the Distributed Cognition of Edwin Hutchins. Advances in neuroscientific research revealed new dimensions of the mind-body relation which gave rise to new work in philosophy of mind. Lakoff and Johnson's 1999 volume Philosophy in the Flesh is perhaps the best known of these. [2]

This movement met media artists coming the other way, as it were – exploring the application of computational technologies to embodied, material and situated cultural practices. The crafting of embodied, sensorial experience being the fundamental expertise of the arts, an expertise which is as old as human culture itself. It is a telling and persistent failure of interdisciplinarity – directly pertinent to the development of ubiquitous computing - that while media artists were at forefront of such research, the two communities had limited connection. [3] The transition from VR to more nuanced augmented and mixed reality modes deploying VR's stock-in-trade tracking and simulation techniques indicates that Ubiquitous computing on-the-ground is less the kind of antithesis of VR which Weiser envisaged, and more of a continuity. Likewise, various topics of critical discourse lumped-in with discussion of the virtual have persisted, and in particular, many of the aesthetic projects of 'media-artists' are inherently concerned with the central issues of ubiquity.

Ubiquity : figure and ground

'Ubiquitous technology' is applied to two quite different types of technology. One is industrial and embedded, effectively invisible and accessed by experts. The other is consumer commodity, very visible and demanding of attention. Although the two categories have much in common technologically, they very different in their manifestation in the world. Intelligent buildings, augmented spaces, complex machines as well as communications networks themselves, have made the transition to quasi-organisms with digital nervous systems. Cars, planes, refineries, hospitals, bridges, utility infrastructures, seismic faultlines and national borders are now increasingly digitally instrumented. These truly 'embedded' technologies are generally small, low power, distributed and networked – in practice invisible, with no (immediate) human interface, no screens no keyboards (an LED if you're lucky !). These systems have been integrated into existing contexts and have thus edged such systems a little further along the mechanical – electromechanical - analog electronic – digital electronic – programmable – adaptive trajectory. Engines run a little smoother and cleaner, industrial workplaces have fewer workers and fewer accidents due to human error, illegal immigrants are intercepted more efficiently. The term 'embedded' cannot escape the echoes of Pentagon terminology, and perhaps this is not trivial. It is a question of to what ends the technology is deployed and whom it is working for or against. While the technical modalities of the technology are revolutionary, the goals are the rather mundane and conventional ones of (panoptical) control.

While Mark Weiser, John Seely Brown and others made clear their motivations for a 'calm technology' that recedes from attention; and much progress has been made in the development and deployment of miniaturised, networked, interfaceless devices; in consumer goods, the obsession with the interface does not seem to have abated, the ecstasy of computation - if not the ecstasy of communication - seems to nave become a fixture of popular culture. While miniaturisation and wireless networking have indeed moved 'out into the physical world', it has not resulted in 'repositioning it in the environmental background' (Ekman, this volume). Rather, the miniaturised but intensified interface, attention demanding and insistent, is foregrounded. While the technological infrastructure (cell phone reception, etc) has indeed become ubiquitous, on the level of human experience, the dataworld and the physical world remain rather discontinuous.

Old wine

Even given Weiser's oft cited interest in and magnanimity towards anthropology, phenomenology, feminist theory (etc), there will always be a fundamental tension between the inherently dualist and reductive aspects of technical disciplines and human social and cultural behavior. Whether a result of the culture of the discipline of engineering, of modern methods of production, or of commercial interests and 'market forces': standardization and optimization rules, and ubiquitous technology will not buck the trend. No amount of superficial customizability - touted as an opportunity for you to 'be creative' and 'express your individuality' by choosing among pre-packaged cellphone wallpapers or downloadable ringtones - can obscure the fact that the thing in your hand is 99.9% a standardized consumer commodity digital widget. Plus ça change, plus ça meme chose. At least Henry Ford was unapologetically honest regarding the personalisability of the Model T. The only really 'personal technology' is the uniquely designed handcrafted technological artifact which is either designated an artwork or the work of eccentric tinkerers – and the distinction can be rather unclear.

Mobile wireless technology has certainly become ubiquitous, but not in the way Weiser hoped. The word ubiquitous carries negative connotations - shared to some extent with 'pervasive' - of an oppressive informational monoculture or monopolistic order. In the current economic order, no technology will exist as consumer product unless there is a successful business model. The bald fact of the technology business is that, outside the research labs, it is just that – business. We are unlikely to have much influence. Regrettably, this is a characteristic of the new technological order. The general dynamics of commodity capitalism ensure that we will be served (the same) old wine in new bottles.

Media Art research, before and beyond virtuality

The 90's saw an explosion of interactive art R+D, along with an explosion of discourse, catalysed by the increasing availability of and familiarity with domestic and prosumer computer based media technologies and the force of the marketing rhetoric of the rapidly expanding computer industry - the construction of the 'information revolution', the burgeoning rhetoric of virtuality and related historical fictions. This work was a continuation of the previous thirty years of 'art and technology' and electronic media art research and practice. Driven by traditions of open intellectual inquiry and interdisciplinarity in the Arts. much of it preoccupied with a reconciliation between existing art practices and the capabilities and constraints of emerging computational media technologies. Those that most intensively engaged those issues were visual and media artists, film and video makers, along with a smattering of musicians and composers, dancers, theatre directors and actors, graphic and industrial designers, media activists and others.

The goals and preoccupations of the explosion of interactive art of the 90's, centered on the creative potential of the technology, questions of narrative and embodiment were central. These questions were structured around the three most (artistically) significant aspects of the new technology – real time computation and its capacity to support interactivity; data storage and search; and networking. These in turn, gave rise to the 'spectre of virtuality' – an idea whose very incoherence led to a vigorous and inventive, if chaotic, arts-issue motivated R+D program.

To take the examples of two historically significant early cases: 1988 saw the exhibition of both Jeffrey Shaw's Legible City and David Rokeby's Very Nervous System. Legible City employed a bicycle interface to allow a user to navigate through a realtime 3D virtual world. The deployment of the bicycle interface was both technologically parsimonious and socioculturally savvy. The device reduced the complex diversity of human motion to two variables (forward speed and turning angle) trivially amenable to digitisation, and bodily literacy with this device is almost universal. The interface thus gathered salient and useful input data in an easily manageable form. The relationship between the users' understanding of their actions and the result presented in the screen was comprehensible without training – a key requirement of interactive art.

Very Nervous System brilliantly condensed potentially intractable live camera data into a highly reduced dataflow processable by a very limited machine – an Apple IIe (!) The fact that David was able to do real time machine vision on such a machine was itself a laudable achievement, the fact that the system made intuitive sense to untrained, naïve users attests to his perceptive understanding of the nature of embodied human perception. The key to these economies was the notion of temporal dynamics – David reasoned (explicitly or implicitly) that (machine) awareness of (bodily) change could be deployed as interaction control, without any ponderous frame by frame analysis or object/scene/gesture recognition. Much academic machine vision research has been impeded by an obsession with framewise analysis because it lacked this fundamental insight. Myron Kreuger trod similar ground fifteen years earlier with his 'videoplace' works, which suffered the plight of all such visionary work that occurs before its time – it was incomprehensible for lack of (discursive) context. While such works were framed by the contemporary discourse of virtuality, they often centered on questions of interaction and are very relevant to research in the 'ubiquitous' paradigm.

From the outset, my own goals in my art practice, research and development through the 90's were critically motivated, informed by a history of embodied and situated art practice, and worked against the grain of conventional research. Coming from a background in situated and embodied practices of sculpture, performance and installation, I was never excited by the rhetoric of fantastic immersion, nor by the stereo-visual spectacle. My previous art practice brought to my design of robotic and interactive systems a visceral understanding of the role of embodiment an bodily movement in the engagement of spatialised aesthetic projects and an equally visceral awareness of the ways that experiences are built from the sum and interaction of diverse and multimodal components, the sensorial qualities of materials: rough-sawn wood as opposed to smooth, or varnished; the physical placement of components with respect to the scale of the body and range of movement; the effect of ambient light and ambient acoustics. It was this sculptors sense of the task of crafting the totality of a sensorial and sensori-motoric experience that permitted me a rather different set of insights into the task of interaction design, and at the same time, gave me zero-tolerance for media artworks which presented the work on a desktop computer, seemingly oblivious to the way that the physical appearance of the machine and its associations with the workplace (etc) utterly framed the work in a way which was as aesthetically overwhelming as it was uninterrogated.

My focus was on the bodily experience of the 'user' and the construction of a fluid relation between bodily dynamics and technological effects. This research began in earnest in 1989, with the commencement of an autonomous robotic artwork Petit Mal, whose sole purpose was to engage visitors in large scale bodily interaction – a dance. I pursued these concerns in the mid 90's with the development of Fugitive, a machine vision, driven, motion-controlled digital video installation in a 10m circular room (ZKM 1996-7) and later with Traces, which involved the development of a custom real time volumetric machine vision system for deployment in the CAVE (Ars Electronica 1999). [4] These and related works pursued the creation of an aesthetically rich multimodal interactive experience which users could and would interact with utterly intuitively. There were no input devices, no strap-on sensors, no interaction procedures and no pre-use training sessions. The systems were crafted to respond instantly to the normal bodily behavior of users within the interaction space. [5]

Ulrik Ekman notes: "It is still a challenging and open issue, to put it mildly, how to have context-aware systems try to make relatively well-informed or even intelligent assumptions about users' current situations, i.e., to demonstrate *in actu* and proactively the possibilities for controlling systems that incorporate well-interpreted human intention, individually and/or socially." (Ekman, introduction, this volume, 42). Much of the extensive technical R+D required for the projects concerned the capturing and interpretation of real world events through custom sensor technologies. In such work, the bedrock reality of sensor design is experienced. This fundamental dimension of the development of embedded, situated, context aware systems is often elided in the contemporary ubicomp/informatics context, yet it is fundamental to digital cultural practice in that it combines the brutal pragmatism of engineering with poetic aspirations.

Sensors respond to variation in a specific electro-physical variable. An ultrasonic transceiver measures the time it takes for an acoustic ping to be reflected by the nearest object. A video camera delivers an array of values for incident light. No sensor will tell you 'she has her left hand in the air'. The first challenge of sensor based quasi-intelligent computational action is to identify what changing electro-physical variable can be reliably identified with a particular human action or environmental event. Any such knowledge is based on inference, interpretation and probability, so a major design constraint in such works was 'what can I reliably infer about the world, or the user, from the sensor data, such that a specific system response will be interpreted by the user as relating coherently to their action?' The pragmatic realities of such sensor tasks often mean that the possible range of action of a system is limited and curtailed by what can be known about the world. More often than not, a system's 'expressive potential' is far greater than its range of behaviors as a working system, because of the limitations of sensing. The alternative, to generate output actions based on interpretation of sensor data that is inherently unreliable, has the effect of confusing the user and thereby breaking the chain of interaction as the system 'responds' to behaviors mistakenly attributed to the user.

Contrary to much of the conventional VR/media art of the 90s which represented or depicted in a manner consistent with conventional (pre-computational) static and linear narrative forms, works like Fugitive and Traces were centrally concerned with the users awareness of their ongoing bodily experience, the history of their own embodiment in the context of an aesthetic environment contrived to provoke certain kinds of explorations. The 'subject matter' in these works was the users experience of their own ongoing bodily engagement with the system. It was not unusual (and it was amusing) when users emerged from their experience of such works sweaty and panting, a testament to their desire to explore the full gamut of possibilities of interaction. Users had no immediate awareness that any computer technology was involved, nor was their any obvious task or purpose to them. These works explored the development of systems which were ubiquitous in the sense of being embedded, calm, and deeply 'context aware'. They presented an experience of technological immanence. They encouraged and rewarded exploratory play.

In the early 90's attempts and commodification and commercialisation of camera based interaction systems began, such as the Canadian Mandala Systems. Transitional technologies included the commercialisation of the webcam and related technologies, along with camera based pc and gamebox game interfaces in the late 90s such as Gameboy camera, and the Logitech Eye Toy for Sony Playstation 2 game interface. Twenty (or in Kreuger's case, 35) years later, the intellectual work of that community of ad hoc researchers is fully commercialized. In December 2008, the Nintendo Wii became the most popular gaming platform in the USA, and a new generation of interactive art students are busy hacking wii controllers as interactive art interfaces. These developments may be taken as indicative of a general historical process in the media arts field: vanguard R+D work often occurs outside state institutions and corporate labs, a decade before such issues register in technical disciplines and two decades before they are commercialised. [6]

Skeuemorphs rule ok?

David Mindell reminds us: “Our computers retain traces of earlier technologies, from telephones and mechanical analogs to directorscopes and tracking to radars.” (Mindell, 2004, 321) The physical conformation and functionality of the machine we use is determined by the history of technologies from which it arose. Interactive multimedia, we must recall, is the child of Cold War computing research. The SAGE (Semi Automatic Ground Environment) system put soldiers with keyboards and lightpens in front of monitors, to accomplish the complex pattern recognition functions which the system could not autonomously achieve. This constellation of technologies was the model for the keyboard-mouse-monitor paradigm. The fact that this harnessing of flesh to machine was later clad in the rhetoric of liberation in the heyday of interactive multimedia remains deeply ironic.

Why did the computer, which once was a basement sized machine staffed by attendants, morph into a desktop machine? The historical answer is that it was applied the kinds of tasks which people who sit at desks do when sitting at desks. Functionally, the desktop computer was an enhanced typewriter and calculator with added filing-cabinet functionality. It follows then that it is particularly useful and relevant for activities which resemble office desk activities, such as record management, accountancy and letter writing, and is decreasingly appropriate for activities whose social and architectural placement diverges from that scenario. Many human activities, including cultural and artmaking activities, do not resemble office work in their physical contexts, methodologies or goals.

For the last generation, we have managed with computer technology which, for all its touted user-friendliness, has continued to demand that we preprocess our thoughts and experiences into a kind of keystroke mush which is easily amenable to the limited a-d capability of these machines. If we are to pursue the fundamental goals of Weiser’s ubiquity, it means developing computational technology past the stage that we and it appear to have got co-dependently stuck in - tolerating a technology which must be spoon-fed with little alphanumeric streams. Mercifully, after thirty years of personal computing I no longer have to always position myself in work-position at my work-station, from which I cannot move even a few feet without breaking my connection with the machine by losing contact with screen and keyboard. But why, having finally freed ourselves from the bondage of the desktop, do we tolerate having to poke unidigitally at a miniature QWERTY on our mobile devices? What a profound failure of imagination!

In terms of human interaction, the epitome of context-aware hardware is the direct neural implant, but this is as unviable as the full-body force-feedback suit of VR fantasy. The technical challenges of the direct neural implant leave any meaningful implementation firmly in the realm of cyborg fiction and happily so, as the desirability of such a deep integration with digital consumer widgets remains dubious for any number of reasons. In any case, contemporary neuroscience would suggest that there is a limit in-principle to the integration of digital technologies with human neurology. It may be possible to drive a prosthetic arm by signals extracted from amputated nerves, but the concept of the plug –in memory chip is based on a fallacious, simplistic and mechanistic notion of the nature of human memory.

Trying to be calm

There is a significant difference between enhancing the control systems of existing machine complexes and the enmeshing of computational processes with human (or animal) biological processes. I've distinguished between, on the one hand, clandestine, retiring or faceless technologies which involve distributed units in a larger control array which itself is embedded in a larger machine complex; and on the other hand, garrulous, clingy technologies close to the body. Neither of these seems particularly *calm*. Beyond embedded miniaturization (microcontrollers), location (tracking) and transmission (internet and wireless communication), how far have we come along the trajectory to *calmness*?

Assuming a future of ubiquitous technology which is on or around but not *in* the body, how should we interact with it and what should it do? Do I need 'blueteeth' that notify my dentist directly when they sense decay? Probably not. I certainly don't feel the need for pop-up ads on the periphery of my vision when I'm wearing my sunglasses. Are there aspects of our lives where digital intrusion might be utterly undesirable? To ask this question is to challenge the normalized orthodoxy of the necessary place of the computational in all walks of life. This is the dark side of ubiquity: the assumption of the desirability of the intrusion of computation into all walks of life : that automated processing of logical operations is necessarily applicable and an adjunct to every aspect of life. Computation is not value-free cognitive bedrock. There is nothing 'neutral' about the culture of computation, even if we are naturalized to it.

That is not to say that such issues are foregrounded in everyday use of consumer devices, but it is a fair question, seldom asked, to query: in what more or less subtle or insidious ways does the normalisation of human activities bent to the needs of a not entirely calm technology stain or perturb the prior richness of those practices? I am thinking here of cultural practices in particular, ie those human practices which have developed organically over generations, subtly adapted to the complex richness of human formation, where artifacts have co-evolved in ways which adapt and optimize subtleties of human sensori-motoric capabilities, which may never have been, nor have had to be, made explicit.

Consider two examples, one high, one low: the culture of the violin and the culture of the household kitchen. What makes a Stradivarius so much more of a violin than a cigar box with a rubber band stretched over it? The special quality of such an instrument is that it has been formed through an extended period of interplay between artisans and players. A history of co-evolution between the material specificities of the artifact and the repertoire, an increasingly refined atunement between the embodied intelligences of the artisan and the musician. A Kitchen likewise evolves as a workplace through use - chains of intuitive design tweaks - a subtle interplay between the ingredients, artifacts and procedures of specific cuisines and the physical capabilities of its users.

In such contexts the application of digital technologies almost always has the effect of 'thinning out' the experience in question, and this is due no doubt to a traditional preoccupation with problem solving on the symbolic plane and thus the eliding of the significance of situation and materiality. This familiar syndrome maps onto imperatives of computer engineering – modularity/reductivism, standardization/generality, optimality/efficiency – instrumentality generally. These criteria are valid in their 'home territory' – I want my laptop battery to have maximum life, I want my file to be compatible, I do not want anyone taking aesthetic liberties with the shape of an airplane wing. But the validity of these criteria wanes as they are applied in territories further from home. Optimisation of King Lear or Beethoven's 5th by elimination of redundancy is an inherently ludicrous proposition.

The profundity of material being

The term 'Human factors' speaks volumes about the engineering mindset - as if the qualities of human embodiment were peripheral, 'implementation details'. It is cognitivitism thinly disguised, in the sense that thinking, or computation, is taken to be an end in itself, rather than part of the process of ongoing lived being. Existing technological paradigms are rooted in a rather Victorian and inaccurate characterization of human perception and action, inflected with dualism, serial processing (input-output) and cognitivism (intelligence/thinking as symbol manipulation). The crisis of the cognitivist model led to renewed attention to embodied, situated and material aspects of cognition. This new cognitive science is immediately relevant to the still-vexed 'human factors' aspect of ubiquitous computing, precisely because it addresses aspects of human experience pertinent to the development of richer and more subtle, if not calmer technologies of interaction.

Getting out of the cognitivist cul de sac demands a wholesale paradigm-shift and a new set of axiomatic assumptions: mind and body are not separate or separable; self and world is likewise an invidious distinction; intelligence is making sense of the world; thinking occurs at the fingertips and in the soles of the feet, in the process of interaction with the world. Calm, embedded, context aware technology implies a phenomenological understanding of being-in-the-world, or, rather of a performative 'doing-in-the- world', of situated sensori-motor action. Coming to understand the emergence of meaning through a temporal process of bodily interaction with things and people in the world is to engage what Andy Pickering has called the Mangle of Practice (1995). In his work of the same name, Pickering captures a key aspect of the paradigm shift I am arguing for in his distinction between what he called the representational idiom and the performative idiom. In these terms, the cognitivist paradigm is firmly rooted in the representational idiom. I propose that the pursuit of ubiquity demands a post-cognitivist approach attending to embodiment, to the performative relation to artifacts and the world, and to the relation of cognition to social and cultural formations. In what follows, I give an introduction to such perspectives via a discussion of the work of Edwin Hutchins.

Cognition distributed and embodied

In 1995, Edwin Hutchins published a remarkable work of interdisciplinary scholarship which combined anthropological field work with cognitive science and computational theory. He analysed the group activity of navigation on a ships bridge as a case of 'distributed cognition', in which a group of people performing specific roles and communicating to each other in specific ways, using a highly developed set of tools perform computational tasks. In a more recent paper, Hutchins makes some remarkable observations on Cognition in the Wild, which warrant quotation at length: "In the last chapter of *cognition in the wild* … I argue that cognitive science made a fundamental category error when it mistook the properties of a person in interaction with a social and material world for the cognitive properties of whatever is inside the person. One enduring problem with this claim is that it demands a description of how cognitive properties arise from the interaction of person with social and material world. *Cognition in the wild* provides a profoundly incomplete answer to this question…For the most part, the cognitive processes described in *cognition in the wild,* and in other treatments of distributed cognition, are presented without reference to the role of the body in thinking. That is, in spite of the fact that distributed cognition claims that the interaction of people with things is a central phenomenon of cognition, the approach has remained oddly disembodied."

I want to dwell upon Hutchins' recognition of the significance of embodiment with respect to the paradigm of distributed cognition, because is it a useful case study of the slow process of de-naturalising axiomatic assumptions in general and in particular, denaturalising such structuring assumptions in cognitive science, that is, of the paradigm shift which is occurring in cognitive studies. [7] Cognition in the Wild can be read as an attempt to recuperate an existing functioning and historically acknowledged system to cognitivism, that is, to do the imperializing work of the discipline which Philip Agre in the following passage, ascribes to the computer (as reification of the discipline, one would assume): "A computer…does not simply have an instrumental use in a given site of practice; the computer is frequently about that site in its very design. In this sense computing has been constituted as a kind of imperialism; it aims to reinvent virtually every other site of practice in its own image" (Agre 1997).

When Hutchins translates one activity into the terms of another, explaining navigation in terms of computation; the authority of this translation is given by the (presumed) authority of the discourse of computation. To claim navigation on the deck of a ship at sea in the name of Cognitivism is analogous to Columbus claiming Hispaniola in the name of the Queen of Spain while rather obstinately ignoring the obvious fact that the land was already claimed, named and occupied. The ability of the crew, based on their training and process, tools and artifacts, was demonstrably effective and acknowledged long before computational explanation – recall that the expressed purpose of Babbage's Difference Engine was to calculate tide tables for the British navy – aids to precisely the kind of navigation Hutchins observed.

In what way and for whom did Cognition in the Wild 'explain' coastal navigation, or to put it another way: what is the power of the computational explanation? An unreconstructed computational explanation would necessarily explain observed phemonema in functionalist terms (Putnam 1967- since recanted). Functionalism asserts that a mental state is constituted by the causal relations that it bears to sensory inputs, behavioral outputs and other mental states. Cognitivism is just one (computational) version of functionalism. Functionalism has a rather industrial if not von Neumannesque cast in its reliance on the idea of serial processing, inputs and outputs. [8] The cognitivism of Cognition in the Wild is more nuanced. Computation, for Hutchins, is embedded in artifacts and practices – but it is still understood as computation. As cognitive science reaches out further and further into cultural realms where computation is an increasingly alien concept, distinctions between technical and popular usages become increasingly hazy, the imperializing project of computer culture insidiously persists. [9]

Hutchins' acknowledgment of the significance of embodiment is admirable: "Interactions between the body and cultural artifacts constitute an important form of thinking. These interactions are not taken as 'indications' of invisible mental processes, rather they are taken as the thinking processes themselves." Such sentiments are not uncommon in the post-cognitivist community, John Sutton has similarly noted "…thought is not an inner realm behind practical skill, but itself an intrinsic and worldly aspect of real-time engagement with the tricky material and social world." (Sutton 2008). To permit that bodily motion may constitute the medium of thinking itself is a radical assertion for a rehabilitated cognitivist, but will come as no surprise to the dancer or practitioner of martial arts, nor to any thoughtful person while rock climbing or hanging out the laundry. But we must not underestimate the profundity of this sea-change in cognitive science, it indicates a hard-won emancipation from naturalization to the tenets of AI, as Philip Agre so lucidly documents. He credits his reading of Foucault's The Archeology of Knowledge specifically and poststructural writing generally as an epiphany: "…they were utterly practical instruments by which I first became able to think clearly and to comprehend ideas that had not been hollowed out through the false precision of formalism." (Agre 1997).

It is precisely this 'false precision of formalism' that hollows-out embodied knowledge. As Aldous Huxley observed long ago, 'In a world where education is predominantly verbal, highly educated people find it all but impossible to pay serious attention to anything but words and notions' (Huxley, 1954)[10]. Numerous students of embodied cognition, from Michael Polyani to Evan Thompson, have stated what practitioners and teachers of embodied cultures have always known: the skills of bodily know-how are notoriously hard to document: such thinking is inherently non textual and non-intersecting with textual representation and text-based reasoning. John Sutton notes in regard to the skill of the potter: "Because this kind of expertise relies on an immense reservoir of practical skill memory, embodied somehow in the fibres (sic) and in the sedimented ability to sequence technical gestures appropriately, verbal descriptions of it (by either actors or observers) will be inadequate…what the expert remembers is in large part consciously inaccessible as well as linguistically inarticulable" (Sutton, 2008). Philip Agre puts the complementary point when he observes that computational fields "concentrate on the aspects of representation that writing normally captures. As a result, theories will naturally tend to lean on distinctions that writing captures and not on the many distinctions that it doesn't." (Agre 2003). It is precisely this discontinuity which creates a deep tension in the modern academy between the pedagogy of the textuo-symbolic regime and the pedagogy of the arts and other embodied practices – accounting for the failure of interdisciplinarity noted above.

Such (embodied) thinking is not computational in the usual sense, so any attempt to recuperate it to the world of computation has to force it through several transmogrifications to fit a linear, atemporal, Boolean mode of representation. The framing of group performance on a ships navigation bridge as distributed computation in a computational-cognitivist world-view was a tour de force by Hutchins. Yet, as he himself notes, the bodily dimensions of thinking such analysis rendered irrelevant or invisible. "The processes that underlie the 'Aha!' insight remain invisible to a computational perspective in part because that perspective represents everything in a single mono-modal (or even a-modal) system. A careful examination of the way the body engages the tools in the setting, however, helps solve the mystery of how the discovery was made, and why it happened when it did. The insight was achieved in and emerged out of the navigators bodily engagement with the tool." (Hutchins, 2006)[11]

Hutchins comes close to the work of Mark Johnson (1987, and later Lakoff and Johnson 1999) regarding the origins of abstract concepts in embodied experience when he notes: "Motion in space acquires conceptual meaning and reasoning can be performed by moving the body" (Hutchins, 2006). Here is revealed a fundamental cognitive cauterisation amongst all but the most sensitively designed interfaces and interactive systems – a situation which has beleaguered digital arts practices : they ignore and erase bodily engagement of the sort that complement material artefacts and tools developed over years or generations and which, taken together, facilitate bodily reasoning. The navigators hoey, the engineers slide rule, the machinists caliper, the carpenters square are amenable to computational explanation, because (loosely) what is involved is a relatively simple translation of geometry to algebra. The painters brush, the violinists bow, the harvesters scythe, and so many other artefacts, are complex and sophisticated devices for thinking with because they have evolved in a deep structural coupling with the basic rhythms and modalities of neural circuits and sensori-motor loops. They are prosthetics which integrate with the user at a deep and more organic level precisely because they do not involve a translation into and out of mathematico-logical computation. On the subject of artifacts, Hutchins notes: "By interacting with particular kinds of cultural things, we can produce complex cognitive accomplishments while employing simple cognitive processes." (Hutchins 2006) [12] Aspects of the environment are deployed as off-board memory, and consistent with Hutchins' notion of distributed cognition, computation is offloaded too.

But are we not, in framing the situation in this way, reinstating precisely the computationalist bifurcations we sought to avoid? Not simply of storage and processing, but of the world and representation? Lambros Malafouris asserts that it makes little sense to speak of one system representing the other. "Although we may be well able to construct a mental representation of anything in the world, the efficacy of material culture in the cognitive system lies primarily in the fact that it makes it possible for the mind to operate without having to do so, ie, to think through things, in action, without the need of mental representation." (Malafouris, 2004). Micronesian canoeists gather knowledge about undersea geography, colloquially 'through the seat of their pants' (if they're wearing any), but more accurately through a subtle integration of proprioceptive and vestibular cues related to the movement of their craft (canoe, catamaran) as a prosthetic extension of their embodiment. Hutchins goes on to rightly observe: "From the perspective of formal representation of the task, the means by which the tools are manipulated by the body appear as mere implementation details." (Hutchins, 2006). [13]

The phrase 'implementation details' tells the score before the game begins. It belies a commitment to dualism that will automatically render invisible or irrelevant aspects of embodiment. Explanation of a group human activity in terms of computation will inevitably render invisible the significance of embodied practice because the irrelevance of embodiment is axiomatic to the rationale of the discipline. 'Implementation details' is a phrase which stands in for an entire corpus of disciplinary rationalizations to justify the disembodiment of AI, as first articulated by Herbert Simon: "Instead of trying to consider the 'whole man', fully equipped with glands and viscera, I should like to limit my discussion to Homo Sapiens, "thinking man" (Simon 1969, 65). This arbitrary and convenient 'limit' in the 'root document' of cogntivism is a veritable Pandoras Box, which permitted the excision of embodied situated materiality from AI and cognitive science for a generation. The devil is not so much in the (implementation) details as in the desire to ignore them. 'Implementation details' cannot be swept under the rug. The term is another of those 'weasel words', like 'human factors' which has let the technical community off the hook as it were, allowed it to sidestep the overarching importance of human culture – engagement of which would of course demand a challenging interdisciplinarity which always has the awkward potential of destabilizing axiomatic assumptions.[14]

Conclusion, or (with apologies to Joseph Beuys):
How to explain embodied being to a (dead) computer.[15]

Two decades ago, at the emergence of the 'reactive robotics' movement, Rodney Brooks critiqued the reigning representationalism in his pithy assertion that: "the world is its own best model" (Brooks 1990), a sentiment which was sympathetic to emerging paradigms of situated and distributed cognition, and also with Hubert Dreyfus' phenomenological critique of AI, which itself was consistent with emerging paradigms of embodied cognition.

By virtue of evolutionary selection, there is direct cognitive correlation between the world and the bodily experience of it. This results in a kind of (performative) knowledge and (non-)cogitation irreconcilable with the cogntivist 'physical symbol system hypothesis' [16]. But it is this embodied, situated knowledge which provides the basis for precisely such cogitation, and for introspection.[17] This is the lived solution to the symbol grounding problem (Harnad, 1990). This double - that the world is its own best model, and that there is direct (non)cognitive correlation between the world and the bodily experience of it - is the core of the post-cognitivist position. It is true paradigm shift, which must be thoroughly internalized if real progress is to be made in the development of 'calm' technology.

The period of development of (ubiquitous/consumer/computer/digital) technology in which it could be (and needed to be) developed in vacuo, in the lab, is resoundingly over. It must now be considered for what it demonstrably is, an integrated component of social and cultural fabric, like automobiles and telephones. In my opinion, a rigorous engagement of post-cognitive perspectives, offers the prospect of new approaches to 'calmness', context awareness, and other murky 'human factors' which have to date stymied the project of ubiquity.

Simon Penny, Los Angeles, 2009

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[1] Like any academic buzzword, many theorists (Brian Massumi among others) adopted and adapted the term Virtuality to their own theoretical ends. In my discussion here, I limit my use of the term to refer to those uses which are concerned with a direct interaction with sensor and data-driven technological systems.

[2] See also (Bechtel et al, 2001) and for an earlier perspective, (Churchland, 1989).

[3] Certain initiatives stand out as beacons through the 90s – such as the artist in residence program at Xerox PARC, the Ars Electronica Futurelab, V2 in Rotterdam, ZKM, the Banff New Media Institute, the Australian Network for Art and Technology, and more recently Intel Labs.

[4] See http://ace.uci.edu/penny/works/traces.html, http://ace.uci.edu/penny/works/fugitive.html, http://ace.uci.edu/penny/works/petitmal.html, etc.

[5] through the 90's I also pursued research in distributed, semi-autonomous multi-agent systems systems, not resident on the net but in free standing communities such as the emergent sound installation Sympathetic Sentience. See http://ace.uci.edu/penny/works/sympathetic.html. I submitted 'caucus', a robotic multiagent project based on Petit Mal, to the NSF in 1996. It was not funded, but several years later, the NSF established special funding specifically for flocking and swarming multi-robot research.

[6] see Penny 2008.

[7] In this discussion it is not my intention to portray Cognition in the Wild as anything other than a major work.

[8] There are of course, theories of cognition which dispute not simply that seriality but the very existence of 'inputs' and 'outputs' as phenomena in the organism, as opposed to representations imposed by the observer, for instance the Autopoietic theory of Humberto Maturana.

[9] A phenomenon I've referred to elsewhere as a Trojan Horse effect, see (Penny 2007).

[10] quoted by Pickering in an unpublished paper Against Human Exceptionalism, University of Exeter, 2008.

[11] Navigators talk of 'thinking like a compass', Hutchins notes "The bodily anticipation of clockwise rotation becomes a somatic anchor for the concept of increasing bearing number value" – that is, a clockwise bodily twist corresponds to increasing numerical value.(Hutchins, 2006)

[12] This statement is akin to any of a number of approaches in philosophy of mind and cognitive archeology which talk of offloading memory and/or computation onto a structured environment, such as the Extended Mind Hypothesis (Clark and Chalmers) or Exograms of Donald.

[13] Philip Agre makes a similar argument: "…a theory of cognition based on formal reason work best with objects of cognition whose attributes and relationships can be completely characterized in formal terms." (Agre, 1997). In the study of material culture, little can be 'completely characterized in formal terms'.

[14] This reticence is understandable in terms of the construction of the technical disciplines and academia in general. Interdisciplinarity in such contexts is generally meek and unadventurous, precisely because of the fear of moving beyond ones own valorized and specialised expertise. This is an academic catch22, as I've quipped previously: 'Fools rush in, but he who hesitates is lost' (see Penny 2009). That is not to say that innovative efforts have not been made in some quarters – the humanistic informatics movement arising in Scandinavia in the 1990's, and some aspects of what is referred to as 'digital humanities' in the USA and elsewhere. The informatics department at the University California

Irvine, is notable within schools of computer science for its openness to perspectives from anthropology, sociology and the arts.

[15] Joseph Beuys, How to explain pictures to a dead hare. performance, Galerie Alfred Schmela, in Düsseldorf. 1965.

[16] 'A physical symbol system has the necessary and sufficient means for general intelligent action'. (Newell, Alan, and Herbert Simon, 1976).

[17] This idea is related to the notion of the cognitive unconscious as develop by Lakoff and Johnson, in Philosophy in the Flesh.