Materiality, Movement & Meaning:

Architecture and the Embodied Mind

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Writing in 1993 on the relations between technology, language and cognition, the anthropologist Tim Ingold provided what appeared to be a perfectly clear and precise definition of the tool as a 'prosthetic' extension of the body:

> "A tool, in the most general sense, is an object that extends the capacity of an agent to operate within a given environment." (Ingold, 1993: 433)

In the context of Ingold's discussion of the agency of tools and technologies, it could be argued that this statement actually assumes what it sets out to explain - that is, it assumes that we already know what constitutes an 'agent', and that we can therefore speak of the tool as a simple linear extension of an agent's ability. In fact, it may be more accurate to say – if we consider this question within the 'long duration' of the evolutionary emergence of the modern human being - that the tool, in reality, came first. Or, at the very least, I want to argue that technology is in fact mutually co-implicated in the gradual emergence of human agency over this long evolutionary timescale, and – the reason why I think it's so important – it continues to be so today in terms of our everyday experience. The claim I want to make by the end of the paper is that the kind of buildings that bear witness to this process of emergence are the ones that best support our sense of well-being, in the broadest possible terms.

To begin with, I'm thinking here of two related examples of emergence: firstly the ontogenetic process – how we as human beings mature into apparently rational sense-making individuals, when we didn't start out that way at birth – and secondly, what we might call (after the editor of Alexander Luria's book on *Language and Cognition*) the 'micro-genetic' process by which we make sense of our ongoing flow of embodied experience 'in real-time' as it were, of what actually goes on in that curious overlapping of immediate past with anticipated future that we usually refer to as 'the present moment'. Of course I'm thinking here of Edmund Husserl's analysis of the consciousness of time as a multi-layered experience of what he called 'retentions' and 'protentions', and also of the more recent work by the neurophilosopher Daniel Dennett in his book *Consciousness Explained*, from 1991, where he explores these ideas in a much more accessible way, also drawing on more recent experimental data from research in the neurosciences.

In order to explore this apparently circular relationship between the human and the technological, in what follows I will describe some examples of the ways in which we engage with technologies on a day to day level, and how the process of 'incorporation' – literally, absorbing into our body-image, or more accurately our *body-schema* – entails a number of important cognitive consequences. In the final part of the paper I will also try to outline what I think this might mean for the continuing relevance of tectonic articulation and materiality in architecture, for example, in the creation of engaging and richly layered environments that contain visible traces of both the processes of construction and occupation – spaces that invite engagement with both the bodies and minds of future building users. And this is the reason why I think this way of thinking about time, as just mentioned, as a multi-layered continuum of past recollections and future projections – especially in relation to tools and technologies - is so important for architects to consider.

Technology and Embodiment

The classic example of the incorporation of the tool into an extended body-schema is that of a blind person learning to navigate with the aid of a white cane. I take this illustration from the writings of French philosopher Maurice Merleau-Ponty, who described it in his major work the *Phenomenology of Perception* from 1945, (2012: 153). Through a gradual process of exploration and experiment the sensitive surface of the hand is effectively stretched out towards the tip of the cane: information is gathered in as the cane reaches out, and by experiencing the textures of touch and sound an environment begins to be revealed. With skilful use the cane effectively 'disappears' from view, as Merleau-Ponty suggests it ceases to be an object that we perceive in itself and instead becomes a 'medium' through which we experience the world, just like the body itself. The use of the cane is gradually sedimented into a behavioural - and therefore also a perceptual – routine: it becomes part of the repertoire of bodily skills and abilities that we use every day to navigate our way through familiar and not-so-familiar environments. Now, we could argue that this is exactly how most people – especially non-architects – encounter a piece of architecture: not as an object perceived directly, in a deliberate way as the focus of attention, and likewise not completely ignored as a kind of anonymous background, but rather experienced more-or-less unconsciously through a form of 'bodily cognition', as a medium through which we experience the task we happen to be engaged in – and of course, a key part of what gives that experience its characteristic texture.

Figure 1: Stelarc - THIRD HAND, Tokyo, Yokohama, Nagoya 1980. Photographer: Toshifumi Ike. © Stelarc / T. Ike..

Another more dramatic illustration of the flexibility and plasticity of the boundary between brain, body and world, can be seen in the experiment carried out by the Australian performance artist Stelarc, adding a prosthetic 'Third Hand' to his own biological body (Massumi, 1998: 336). The hand is controlled by nerve impulses picked up from surface electrodes attached to his upper thigh and abdominal area. While the device took some time to learn how to operate – basically by a process of trial-and-error experiment – with practiced use it can be quite precisely controlled, independently of the artist's two biological hands. This example also reminds us of the fact that - from birth onwards – we have all passed through a similar process of exploratory bodily 'training', swinging our limbs about more or less wildly until we gradually learn how to control and apply them, and to reach out and take up other bits of the world in order to extend our bodily capacities.

The idea that technical extensions of the body can also become intrinsic to our individual sense of self is also suggested by the philosophers Andy Clark and David Chalmers in their 1998 essay 'The Extended Mind'. They describe how we commonly rely on various technical props and supports to help us to deal with everyday mental tasks, from note-pads and pencils for writing down ideas to electronic calculators and digital search-engines for retrieving and manipulating useful information. The all-too-familiar misfortune of losing a wallet or a mobile phone also reminds us how distressing it is to be denied access to what can suddenly seem like a vital organ. Robbed of our taken-for-granted ability to make phonecalls, look up addresses, check diary entries and access the internet, it is easy to feel that we are not quite the complete person that we

previously assumed we were. Likewise with the kind of crisis of self-identity that often accompanies a loss of memory and a lack of ability to navigate complex environments that can often be a consequence of the degenerative illnesses of old age.

As if to dramatise this reliance on the ability of the environment to 'think for us' so to speak, the French philosopher Bernard Stiegler in his book *Technics and Time* (1998) even goes as far as to say that - far from being simply an optional extra – these technological extensions that we routinely incorporate into our extended body-schema should be seen as a fundamental part of what it is to be a human-being (1998: 152). In the next section I will explore this idea within an evolutionary framework, drawing an analogy between the ontogenetic processes that we have just been considering (the development of the embodied individual enhanced by various technical extensions), and the longer timescale of the phylogenetic process by which the human species itself can be seen to have emerged. To do this, I will be apply a model of 'circular causality' – the idea that a kind of feedback loop between technical development and biological mutation has been helping to steer the course of human evolution. Or, in relation to architecture, as Winston Churchill once famously said: "We make our buildings and thereafter our buildings make us" (1951).

My first piece of evidence is taken from a recent book called *The Prehistory of the Mind* by the cognitive archeologist Steven Mithen. In it he shows a timeline of the development of early Hominid species, showing increases in average brain size over the last 4 million years (1996: 7). The key points are the two major periods of significant brain enlargement, initially from about 2 million years ago, and then again from half a million to 200,000 years ago. In parallel with these developments archeologists have also found evidence of the emergence of early stone tool technology, in the period from 2.6 million years ago, up to 250,000 years ago, showing the increasing complexity of strategic planning involved in the transition from so-called Oldowan to the more advanced Late Acheulean tool-making processes.

Of course, it is difficult to infer direct causality in one direction or the other: one might claim that bigger brains are the 'cause' of more complex technology – or, equally, I could try to claim that it actually works the other way round: the existence of more complex tool-making practices could be the selective pressure required to 'cause' the preservation of genetic mutations that happen to confer additional tool-making ability. What I actually want to claim here is simply that both these forces are interacting in a circular process of mutual support.

Another important point worth noting about this evolutionary development is the relation between these early technical practices and the emergence of spoken language. While evidence for the existence of language is notoriously difficult to find we can at least infer it from fossilized anatomical fragments. The increasing complexity of the vocal tract, as well as the size and shape of the skull, both imply the possibility of early human linguistic ability. And there is also the circumstantial evidence of sophisticated social interaction that could have been facilitated by verbal communication which is suggested by the archeological remains of complex communal settlements.

This potential evolutionary link between technology and language has also been described quite recently by the neuroscientist Michael Arbib in a chapter of the book called *Architecture and Neuroscience*, published in Finland in 2013. Arbib has been writing on this theme since his earliest work from the 1970's but in fact it is an idea that has been around since at least a decade before that.

In research from the 1960s which is published in English in the book called *Gesture and Speech*, the French paleo-anthropologist Andre Leroi-Gourhan had also found evidence of a neural feedback circuit that seemed to connect technical and linguistic ability. A key part of his evidence was based on the organisation of brain activity in the sensory-motor cortex, where the major areas devoted to control of the hands and the vocal apparatus are located in immediately adjacent areas. He supports his claims with a dramatic image

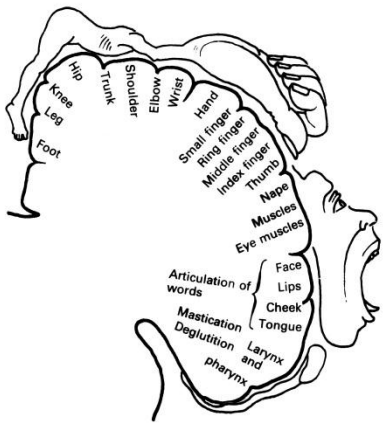


Figure 2: Andre Leroi-Gourhan – Cortical picture of voluntary motor function (after Penfield and Rasmussen). Right hemisphere of human brain in cross-section. © MIT Press, 1993. P. 82.

taken from the 1940s work of neurologists Penfield and Rasmussen, showing where the major parts of the body's sensory-motor apparatus are processed within the brain (1993: 82). This diagram also emphasises the variation in the proportions of cortical space given over to the different parts of the body, with the largest areas devoted to those needing the most precise levels of control and articulation.

Leroi-Gourhan also partly bases his argument on the evolutionary shift from moving on all-fours to walking upright, claiming that this innovation simultaneously liberated both the hands and the face for new uses. In place of their previous focus on ground-based movement and exploration, both are now able to be employed in new forms of communication. He further suggests that manual ability with tool-making might have provided the initial stimulus to the use of the hands to communicate, thus encouraging a refinement of a kind of proto-language of bodily posture into a set of more precisely articulated manual gestures. This idea has been further developed more recently in the work of the evolutionary psychologist Michael Corballis, in a book called *From Hand to Mouth* published in 2002, as well as by Tim Ingold, who I mentioned earlier, in an edited volume called *Tools, Language and Cognition in Human Evolution* (1993). Ingold makes the connection more convincingly in my view, partly in the way he considers language itself as a form of technology –another kind of 'tool' for reaching out beyond the body to make things happen in the world around us.

Leroi-Gourhan for his part, accepts the speculative nature of this connection, given that the early historical traces of spoken language have clearly not been physically preserved. But if we consider the ways in which technical processes and procedures are visibly evident in the form of the tool itself, then perhaps this provides an example of how bodily communication can be captured and passed on from one generation to the next. The French philosopher Jacques Derrida, intrigued by the apparently inferior philosophical status of written as opposed to spoken forms of language, was also inspired directly by Leroi-Gourhan to speculate on the evolutionary function that physical traces of human memory might actually have performed:

> "If the expression ventured by Leroi-Gourhan is accepted, one could speak of a "liberation of memory," of an exteriorization always already begun but always larger than the trace which, beginning from the elementary programs of so-called "instinctive" behaviour up to the constitution of electronic card-indexes and reading machines, enlarges difference and the possibility of putting it in reserve: it at once and in the same movement constitutes and effaces so-called conscious subjectivity." (Derrida, 1976: 84)

With the reference to 'so-called instinctive behaviour' Derrida connects an original impulse towards mark-making with Merleau-Ponty's description of bodily skills and habits as our primordial means of grasping our place and finding our way within the world. That is, he implies that we should think of habitual patterns of behavior as being our first means of capturing and passing on our acquired knowledge of the world (Merleau-Ponty, 2012: 130-148). An idea which also echoes the words of the earlier French anthropologist Marcel Mauss in his essay called "Techniques of the Body" from 1935, where he claimed that: "The body is man's first and most natural instrument. Or more accurately… man's first and most natural technical object, and at the same time technical means..". (Mauss, 2006: 83) As a footnote to this idea, I should also say that Tim Ingold has also recently restated this idea in his book from 2013 called *Making*, where he suggests that the model or pattern for the basic form of the Achulean hand-axe might have simply been based on the shape suggested by the two hands cupped together, palms facing (Ingold, 2013: 43).

To return briefly to the Derrida quotation, it is important also to note what he says about the 'exteriorization of memory' – referring back to the simple tools that we have just been discussing – forms which gradually became both more elaborate and more durable, and perhaps also could be said to mark the dawning of human self-consciousness itself. A kind of self-realisation which is,

as he says, both 'constituted and effaced' in the movement that both solidifies and objectifies the individual identity of the maker within the artefact itself, and, at the same time, projects it out into the world to take its place among countless other more or less anonymous objects.

For another way of looking at this we could turn to the writing of the physician-turned-philosopher Raymond Tallis in his remarkable book on *The Hand*, (2003) where, like Derrida, he also uses this idea as the basis for a theory of the emergence of human self-consciousness. The book elaborates on Freidrich Engels' famous statement that:

> "The hand is not only the organ of labour, it is also the product of labour" (1940: 281).

Tallis suggests that out of the 'objectifying' of human action in the repeated patterns of technical processes and the material forms of tools and artefacts, emerges a growing awareness of the hand itself as a kind of proto-technical object.

While this might also, perhaps, explain the special prominence given to the image of the hand in many examples of paleolithic cave-painting, the major implication of this is that the ability to see one's actions 'sedimented' in the solid residues of technical practices might even have been the stimulus to early humans' sensing of the ambiguous subject-object status of the body: that is, in other words, what Merleau-Ponty has described as our curious status as integrated 'body-subjects'. Therefore, moving beyond the idea of the technological prosthetic that was introduced at the beginning of this discussion: rather than thinking of technology merely as an extension of the human body, it may even be true to say that thinking of ourselves as having a body – and having a choice as to what to do with it – might actually be a consequence of our prehistorical development of technology.

And perhaps – leaping forward again in historical time – this is what Karl Marx also had in mind when he described the satisfaction of the manual worker in the contemplation of an accomplished act of making:

> "Supposing we had produced in a human manner; each of us would in his production have doubly affirmed himself and his fellow men. I would have objectified in my production my individuality and its peculiarity and thus both in my activity enjoyed an INDIVIDUAL EXPRESSION OF MY LIFE and also in looking at the object, have had the individual pleasure of realising that my personality was objective, visible to the senses and thus a power raised beyond all doubt." (McClellan, 1995: 23)

Marx's statement also highlights two complementary forms of creative experience that seem to result from the process of making: firstly the experience of the maker in taking up and transforming a raw material into an object of use, and secondly the experience of the user in taking up an object consciously shaped for human interaction. So, if it is true that we produce ourselves as subjects in the creative action of producing objects, I would argue that we also continually reproduce ourselves as creative subjects in the act of taking up and using objects. The symmetry that this suggests between the process of constructing and both inhabiting and interpreting architecture (Frascari, 1991: 107) is what I want to try and illustrate in the final section of this paper.

Construction and Occupation

On one level, most of what has been said above is simply a reminder that technology in general is, after all, 'much more important than we think'. But, I would also like to suggest that the same kind of body-brain feedback loop as I have just been discussing – over the longer timescales of both evolutionary and individual development – still contributes to our understanding of architecture today, right now, in terms of how we make sense of our environment at each moment we open our eyes on the world. For example, I would argue that we

'read' an environment in terms of two related narratives of interaction, or what could be called encounters or 'collisions' between people and things. I am thinking here of the building as both a historical record of interaction and a kind of future projection, presenting us with the material evidence of both how it might have been made and also how it might be used. What I am suggesting is a direct connection between the tectonic articulation of the processes of construction, and the accumulating traces of occupation left by the users' repeated patterns and habits of use, while also making a further link to the ways in which spaces have been consciously designed for use, or what the American psychologist James J Gibson called the functional 'affordances' offered by an environment. In other words, to paraphrase the thought of the philosopher Paul Ricoeur, we might say that the hermeneutics of architecture involves a double process of interpretation: both of the 'space behind the work' (understanding the intentions of its author, designer and maker) and, even more importantly, the space 'in front of the work'- understanding the experience that the building makes possible for its future 'readers', users and occupiers (Ricoeur, 1981: 141).

One other important element in this brain-body-world relationship relates directly to the link between movement and meaning that I mentioned at the beginning of the paper. Below is an image of an experiment that has been referred to by a number of architects, including Lars Spuybroek in his book 'Machining Architecture' from 2004.

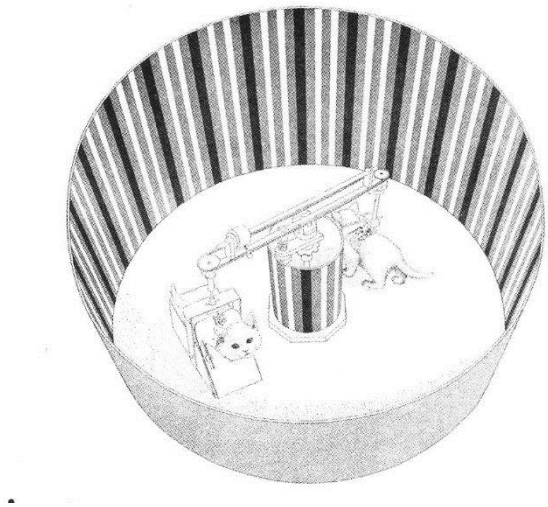


Figure 3: Apparatus for equating motion and consequent visual feedback for actively moving and passively moved kittens. (After: Hein and Held, 1964: 873)

I use it to illustrate one of the key principles behind the connection between perception and action. The basic scenario is that the two kittens involved in the experiment are just a few days old and their brains are developing rapidly – neural networks are being created in response to the ongoing experience of movement. The key issue is that normal development involves a coupling together of visual and bodily information: the brain interprets changing visual perceptions in relation to bodily movement and this is what enables any complex organism to navigate effectively in 3-dimensional space. What goes wrong in this case is that only the kitten on the right can control its own movements – its feet are touching the floor and as it moves around the apparatus its visual perception changes in the normal way – the brain can therefore match these up and the neural circuits can develop normally. The kitten on the left however has no control over its own bodily movement and its brain fails to make this same association. When the kittens are released after a few days inside the apparatus the one on the right can move around normally, but the one on the left behaves as if there is something wrong with its visual system: bumping into barriers or stepping off edges and exhibiting a form of 'experiential blindness'. While the kitten's eyes are actually working perfectly well, the problem is that its brain has not developed the capacity to match up its bodily movements with the associated changes in incoming visual information.

The second piece of neuro-scientific evidence I would like to cite in support of this vital connection between perception and action comes from the recent discovery of the so-called mirror-neuron system, first described by Vittorio Gallese and his colleagues from the University of Parma in Italy. The basic principle is that the neurons involved in the production of bodily movement are also active during the observation of movement in other people. In other words, when I am watching someone performing a particular action I am activating the same neural network as the one that controls my own performance of same action. As the philosopher Shaun Gallagher has described it in his book *How the Body Shapes the Mind*:

> "The recent discovery of 'mirror-neurons' in the pre-motor cortex, neurons that are activated either by the subject's own motor behaviour or by the subject's visual observation of someone else's motor behaviour, shows a direct and active link between the motor and sensory systems.." (2005: 9)

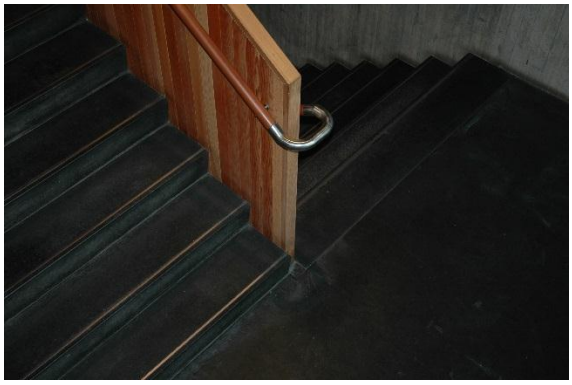
Experiments have also demonstrated marked differences in the levels of activation of the mirror-neuron circuits, with much stronger responses from observers watching highly skilled performers of activities in which they themselves are also trained (Calvo-Merino, et al. 2003). For my own argument in relation to both tectonic and functional expression in architecture, a further link has also been established between the direct observation of bodily movement and the evidence of movement left behind in material forms. In an article from 2007 co-written by Vittorio Gallese and the art historian David Freedberg they describe the process of testing viewers' reactions to various paintings and sculptures that contain obvious physical traces of gestural movements of the artist's hand:

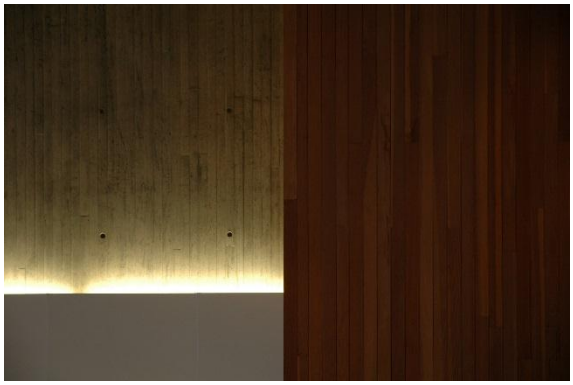
> "With abstract paintings such as those by Jackson Pollock, viewers often experience a sense of bodily involvement with the movements that are implied by the physical traces – in brushmarks or paint drippings – of the creative actions of the producer of the work." (2007: 197)

Examples they looked at included the so-called 'action paintings' of Jackson Pollack as well as the knife-slit canvases of Lucio Fontana. In each case what seemed to be happening in the viewer's brain was a kind of re-enactment of the movements involved in producing the original marks on the canvas. The writers then go on to link this idea to the art historical concept of empathy as a component of aesthetic experience, as developed in the late 19th Century. In basic terms empathy – in German *Einfühlung*, literally 'feeling into' – involves a bodily sense of emotional connection with the scene depicted in a work of art, most obviously via the facial expressions of the figures involved in the action. A similar connection has also been made by one of the major historians of this period in architectural history, Harry Francis Mallgrave, in his two recent books addressing current developments in the emerging field of *neuroaesthetics* (2010, 2013).

To conclude I will refer briefly to one small architectural example of this connection between materiality and movement, which I think also supports the claim I have made above for a kind of 'symmetry' between construction and occupation. This example is taken from a studio project I set for postgraduate students at the University of Nottingham, where the brief was to design an exhibition about a building that would take place within the building itself. One particularly successful project (by John Proctor, Andrew Geldard and Jamie Chubb) looked at the New Art Gallery in Walsall near Birmingham, designed by Caruso St John Architects and opened in 2000. The building is, in basic terms, a concrete box clad on the outside with a shell of ceramic tiles and on the inside partially lined with close-boarded timber panelling which has a vertical orientation following the same layout and module as the boarding used for the concrete formwork. In this juxtaposition of strongly grained timber alongside the texture of board-marked concrete there is already a clear suggestion of the way in which the structure was built. The students took this as inspiration for the construction of a bench made of concrete and timber, which – along with a

video showing the process of its construction – was to be shown as part of the exhibition installation within the gallery itself. Of more interest to me personally was another more subtle detail – apparently less deliberate and more easily overlooked: on the upper landings of the main stairs a number of partial footmarks are visible to the attentive visitor – fragments of builders' boot-prints cast permanently into the concrete floor. While the power-float machines used to finish the floors would normally be expected to smooth these over, in this case the architects have perhaps even encouraged the builders not to be too careful about 'covering their tracks'. As these permanent traces of the construction process appear alongside the more transient footprints left by the building's users, they invite us in a modest way to connect how the building was made to the possibilities of how it might be occupied.





Figures 4, 5, 6: Caruso St John, New Art Gallery Walsall. © J.Hale, 2006.

The powerful sense of human presence suggested by these traces of previous actions – the double presence of both makers and users conveyed by the combination of permanent and transient evidence – reminds us of the potential of architectural materials to act as meaningful surfaces of inscription and communication. What I have elsewhere described as a cognitive dimension to this connection between the tectonics of construction and the 'tectonics of use' (2014), is perhaps best summed up by returning to the words of the philosopher Paul Ricoeur:

"…it must be said that we understand ourselves only by the long detour of the signs of humanity deposited in cultural works." (1981:143)

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