The inorganic open

Nanotechnology and physical being

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But what is an object?

Bernard Stiegler, *Technics and Time*

What is the status of the object in contemporary philosophy? How is the question of the object sutured to particular determinations of the concept of 'life' – a concept that, according to Giorgio Agamben, 'must constitute the subject of the coming philosophy?'[1] And how does the binding of the question of the object to the concept of life determine, in turn, the manner in which we negotiate the question of how modalities of being-in-the-world are connected to forms of material existence?

Such questions are not only in the air; they have crystallized, in less philosophically inflected forms, into the discipline of material culture studies, and more than a few good answers to them have been gathered by Bill Brown into an influential special issue of *Critical Inquiry* entitled *Things*.[2] In Science Studies, Bruno Latour has been leading a non-modern mission to 'rescue the non-humans', and Graham Harman, in the name of a new 'object-oriented philosophy', has urged contemporary thinkers to 'begin funneling arms and humanitarian aid toward some sort of guerrilla realism – a fresh insurgency on behalf of objects themselves'.[3]

Taking up the question of the object, the concept of life, and the problem of being-in-the-world, I direct these towards recent developments in nanoscale materials research and fabrication. These developments have raised the stakes of our opening questions, challenging philosophy to revise and to rearticulate the basic categories into which it has distributed discrepant modalities of material being. The new capacities of material *address* enabled by nanotechnology – the capability to image, to manipulate and to supervise the self-organization of matter at molecular and sub-molecular scale levels – threaten these categories in a number of ways. From the efforts of nanobiologists to build 'molecular motors' by enlisting and expropriating the self-organizing capacities of DNA *outside* the biological enclosure of the cell, to the fabrication of DNA-wrapped carbon nanotubes that operate as sensors *inside* living cells, to 'bottom up' research and development programmes promising to 'assemble artificial cells from scratch using nonliving organic and inorganic materials', the hybrid, nonorganic entities that nanotechnology is *just about* to render operative thoroughly unsettle, displace and reassemble the articulations by which we attempt to differentiate living beings from 'merely' physical matter.[4] As Geoffrey Ozin and André Arsenault note in a recently published textbook on nanochemistry, 'simple, elegant and robust attributes of self-assembly are now being combined with powerful methods of inorganic and solid-state chemistry to create materials with unprecedented structures, compositions and morphologies.' The capacity to manipulate and to characterize matter below the scale threshold at which its properties are determined by its molar composition has made it 'feasible to organize and connect organic, inorganic and polymeric chemical components with well-defined functions into integrated electronic, photonic, mechanical, analytical and chemical systems'.[5]

Such pronouncements are now routine among nanotechnologists and those who follow the development of the field. But while there is no question that nanotechnology has already produced material structures with unprecedented physico-chemical constitutions and genuinely novel properties, its proponents and apostles have had greater success in flaunting the conceptual entanglements with which it confronts philosophical and scientific taxonomies than in disentangling and precisely delineating the lines of demarcation along which it challenges ontological categories. In what follows, I unwind one such thread: the category of phenomenological 'access' as constitutive of living being. Tracking this thread through several recent

challenges to the famous theses of Heidegger's 1929/30 seminar regarding the being of stone, animal and man – and then winding it through the questions of sense and sensation posed by the so-called 'smart materials' engineered by nanotechnology – I follow this line of demarcation towards a concept of 'physical being' that would recognize another sense of what Heidegger calls 'world'. Could we articulate a concept that would thread such a line of demarcation right through the self-difference that the object has always been denied by philosophy? And would the articulation of such a concept make it possible to suture the rift between object and world which that denial has imposed – to sew together the very threshold which the non-living being of the object opens onto world?

Non-living without world (the stone)

> A stone cannot behave in this way.
>
> Martin Heidegger, *The Fundamental Concepts of Metaphysics*

Of the three theses elaborated by Heidegger in the 1929/30 seminar – according to which 'the stone (material object) is worldless; the animal is poor in world; man is world-forming'[6] – it is perhaps the determination of the animal's modality of being that has provoked the most curiosity and the most insistent criticism among Heidegger's commentators. To mention only a few recent examples, the animal's poverty in world has been the primary subject of Akira Lippit's book, *Electric Animal*, of Jacques Derrida's final seminar at UC Irvine on 'The Beast and the Sovereign', and of Giorgio Agamben's *The Open*.[7] The subtitle of Agamben's book, *Man and Animal*, is representative of the manner in which this attention to the animal – or more accurately to the 'simultaneous division and articulation of the animal and the human'[8] – has often come at the expense of critical reflection upon the ontological status of the non-living being: the worldlessness of the stone.

As was the case in *Homo Sacer*,[9] it is the articulation of *life* with which Agamben's analysis of 'the anthropological machine' is primarily concerned in *The Open*. The anthropological machine of Western science and philosophy, Agamben argues, produces a state of exception between man and animal, a zone of indeterminacy in which there 'is neither an animal life nor a human life, but only a life that is separated and excluded from itself – only a *bare life*' (*TO* 38). As might be expected given this focus upon the *bio*political, when Agamben enters into the engagement with Heidegger's 1929/30 seminar that will dominate that latter half of *The Open*, he grants the first term of Heidegger's three theses, the stone, only one sentence: 'since the stone (the nonliving being) – insofar as it lacks any possible access to what surrounds it – gets quickly set aside, Heidegger can begin his inquiry with the middle thesis, immediately taking on the problem of what it means to say "poverty in world"' (*TO* 51). Quickly set aside by Heidegger, the stone, or the 'physical being' of the material object, is set aside even more rapidly by Agamben, whose analysis will not refer to the triadic structure of Heidegger's theses again. At what would seem like an opportune moment for an analytic intervention into the *frame* of Heidegger's thinking, a moment at which to raise one or two questions about the precise status of 'the nonliving', or to interrogate the concept of 'access' that determines Heidegger's denial of world to inorganic entities, Agamben leaves such concerns aside, casually following Heidegger in relegating such beings to worldlessness.

Heidegger's triple thesis is determined by a double distinction: a first distinction between the stone and the animal, and a second between animal and man. The first, which determines the stone as 'worldless' and excludes it from the sphere of 'life', is conditional upon the capability or incapability of beings for phenomenological 'access'. The stone exemplifies what Heidegger calls 'physical being' (*FCM* 192), a modality of being which is negatively determined as non-living, without access to an environment, and therefore without world. The stone is immobile and senseless: 'it lies upon the earth but it does not touch it', it 'crops up here or there, amongst and amidst a host of other things, but always in such a way that everything present around it remains essentially *inaccessible* to the stone itself'. If 'world', writes Heidegger, denotes 'those beings which are in each case accessible and may be dealt with, accessible in such a way that dealing with such beings is possible or necessary for the kind of being pertaining to a particular being', then the stone is worldless in so far as it does not have such access. It is 'essentially *without access* to those beings amongst which it is in its own way'. Worldlessness 'is constitutive of the stone in the sense that the stone *cannot even be deprived* of something like world', and it is precisely the fact of the stone's having no access that 'makes possible its specific kind of being, i.e., the realm of being of physical and material nature and the laws governing it' (*FCM* 196–7).

The animal's way of being, on the other hand, which Heidegger calls 'life', is '*not without access* to what is around it and about it, to that amongst which it appears

as a living being'. In so far as it has access to beings, the animal has world, and it 'stands on the side of man' rather than on the side of the stone (*FCM* 198–9). But the animal is 'poor in world' – as Agamben discusses at length in chapter 12 of *The Open* – in so far as its mode of access is that of captivation by its ring of disinhibitors. Heidegger writes that

> *Beings are not manifest* to the behaviour of the animal in its captivation, they are not disclosed to it and for that very reason are *not closed off* from it either. Captivation stands outside this possibility … to say that captivation is the essence of animality means: *The animal as such does not stand within a manifestness of beings. Neither its so-called environment nor the animal itself are manifest as beings. (FCM* 248)

While the stone is 'simply present at hand amongst other things', the animal 'finds itself suspended, as it were, between itself and its environment, even though neither the one nor the other is experienced as being' (*FCM* 198, 248).

The final eighty pages of Heidegger's seminar are devoted to an analysis of this 'as': a mode of comportment towards beings that is constitutive of 'world-forming' as the essential capability of the Dasein in man. The second distinction of the triple thesis in *The Fundamental Concepts* ultimately depends upon the concept of *projection* as the basis of the as-structure. As '*the fundamental structure of world-formation*', projection is that which primordially opens access to being *as* being, and therefore opens the ontological difference. Projection, that *leaping ahead of itself* of Dasein even as it falls back into its thrown facticity, is the irruption of the 'between' of the ontological difference, and the 'as' designates the structural moment – the relational separation – of that originarily irruptive between. Man is world-forming in so far as 'projection raises us away into and thus unveils the dimension of the possible', and this opening of the possible binds us to the actual *as* a project of formation (*FCM* 362, 364–5).

These two distinctions grounding Heidegger's triple thesis – the distinction of man from animal on the basis of projection, and the distinction of the stone from the animal or the plant on the basis of its not-having-access – are taken up and challenged, in turn, by Bernard Stiegler in *Technics and Time* and Jean-Luc Nancy in *The Sense of the World*.[10] Agamben's analysis of the anthropological machine concentrates on the logical aporia of the genesis of language as that which falls into the irremediable fracture between man and animal. Stiegler carries out an excavation of this fracture, cataloguing its mineral deposits. For Stiegler, what we find in this fracture is the stone. Working from theories of technological vitalism developed by Simondon and Leroi-Gourhan, Stiegler elaborates an account of the rift between animal and man as the site of a genetic drift whereby cortical evolution is codetermined by a process of *technical* evolution, a 'double emergence of cortex and flint'. For Stiegler, it is *this* problematic – the paradox of 'the technical inventing the human' and 'the human inventing the technical' – that precedes the logical aporia of the genesis of language, along with any possible distinction between man and animal. While Heidegger's triple thesis mediates the difference between stone and man through their respective difference from the animal, and while Agamben elides the stone altogether by focusing exclusively on 'man and animal', Stiegler confronts man directly with the inorganic matter that *enables* his evolution. 'Corticalization', he writes, 'is effected in stone' (*TT* 155, 137, 134).

Although Stiegler's analysis of Heideggerian ontology is devoted primarily to the analytic of Dasein in *Being and Time*, the consequences of that analysis for the distinctions deployed in the 1929/30 seminar are clear. Projection is effected by the temporalizing torque generated by that 'leaping ahead of oneself' constitutive of *anticipation* and that 'falling back into everydayness' conditioned by Dasein's thrownness within a context of factical existence.[11] According to Stiegler's analysis, both anticipation and the constitution of facticity depend upon a technical exteriorization of memory that founds historicity and opens futurity. Thus, technics *makes* projection possible, and the world-formation constitutive of Dasein in fact has its groundless ground in 'nonorganic organizations of matter' (*TT* 17). Projection *is* the structural coupling of man and material thing that Stiegler calls 'a 'mirror proto-stage' in the course of which the differentiation of the cortex is determined by the tool just as much as that of the tool by the cortex: a mirror effect whereby one, looking at itself in the other, 'is both deformed and formed in the process'. In other words, world formation is an irreducibly double process, a 'double plasticity' by which the inorganic object and the human are *in*formed of and by the other. In *Technics and Time*, the essence of man falls into an opening *within* the fracture between animal and man: the de-fault of origin between cortex and flint. The question posed by this analysis to the ontological schema of Heidegger's 1929/30 seminar is: 'what plasticity of gray matter corresponds to the flake of mineral matter?' (*TT* 158, 142, 135).

For our purposes here, however, there are two problems with Stiegler's account of the 'invention of the human.' The first is that his writing occasionally imports anthropomorphic language into descriptions of processes of genetic drift. The cortex and the tool are involved in a 'mirror proto-stage … whereby one look[s] at itself in the other [*l'un se regardant dans l'autre*]'. Such a visual metaphor begs the question of 'access' grounding Heidegger's distinction between life and non-living being. The second problem is that, for Stiegler, the stone is only included in the event of world-formation in so far as it functions as a 'technical object' – an 'inorganic organized being' as opposed to the evidently unorganized 'inorganic beings of the physical sciences'. Beginning his study with a critique of the Lamarkian distribution of physical bodies into two classes – 'the non-living, inanimate, inert' and the organic being – Stiegler elaborates the ontology of technical objects as 'a third genre of "being"'. Technical objects, Stiegler argues, 'have their own dynamic when compared with that of either physical or biological beings, a dynamic, moreover, that cannot be reduced to the "aggregate" or "product" of these beings'. 'There is a historicity to the technical object', he writes, 'that makes its descriptions as a mere hunk of inert matter impossible.' Thus, for all of Stiegler's attention to the agency of stone in the event of projective temporalization, the non-living being only has access to world or contributes to world-formation in so far as it ceases to function as a 'mere hunk of inert matter' by becoming structurally coupled with life, and this constitutes a 'becoming-organic' (*TT* 17, 1, 17, 71). In *Technics and Time*, the ontology of 'merely' inert being – introduced on page 1 and recurred to only in contradistinction to the dynamism of the technical object – is ultimately left aside in a manner similar to Agamben's abandonment of the stone.

It is precisely this question of whether or not such a 'merely' inorganic being has any sort of 'access' to world – outside of any *necessary* relation to life – that Jean-Luc Nancy takes up in a chapter titled 'Touching' in *The Sense of the World*. Nancy is one of the few thinkers to challenge Heidegger's determination of 'physical being' directly, quoting the 1929/30 seminar at length:

> The stone is without world. The stone is lying on the path, for example. We can say that the stone is exerting a certain pressure upon the surface of the earth. It is 'touching' the earth. But what we call 'touching' here is not a form of touching at all in the stronger sense of the word. It is not at all like *that* relationship which the lizard has to the stone on which it lies basking in the sun. And the touching implied in both cases is above all not the same as *that* touch which we experience when we rest our hand upon the head of another human being … Because in its being a stone it has no possible access to anything else around it, anything that it might attain or possess as such. (*SW* 59)

Nancy's questions for Heidegger are as follows: 'Why is access determined here *a priori* as the identification and appropriation of the other thing?'; 'Why could the world not also *a priori* consist in being-among, being-between, and being-against? In remoteness and contact without "access?" Or on the threshold of access' (*SW* 59–60). It is this 'threshold' of access that Nancy identifies with the taking-place of 'sense'. Heidegger fails to situate the object at this threshold, Nancy argues, because he 'apparently fails to weigh precisely the weight of the stone that rolls or surges forth onto the earth, the weight of the *contact* of the stone with the other surface, and through it with the world as the network of all surfaces. He misses the surface in general' (*SW* 61). For Nancy, the surface designates the interface of the 'toward-itself' and the 'in itself' – an interface that *is* the world where sense takes place. 'The différance of the toward-itself, in accordance with which sense opens, in inscribed *along the edge of* the "in itself".' The world of sense, or the sense of the world, consists in 'matter forming itself, form making itself firm', and if the stone does not 'have' access, it is not therefore without world. Rather, on the outside of predication, *it is world that without*. World-forming takes place along the surface of that exteriority where 'all bodies, each outside the others, make up the inorganic body of sense' (*SW* 62–3).

Stiegler's intervention into the determination of Heidegger's ontological categories is to fold non-living being directly into man's essence as Dasein by demonstrating the dependency of projection upon the inorganic materials that enable exteriorization. Nancy challenges the worldlessness of the stone by describing the contact of material surfaces as that which forms world by forming the distributed being of sense. These interventions matter in so far as they situate non-living being *within* the formation of world that Heidegger accords only to Dasein, while situating world *outside* the predication of access that Heidegger reserves only for 'life'.

For Agamben, 'Western politics is, in its origin, biopolitics', but in *The Open* the site of the biopolitical is determined only as the conflict 'between the animality and the humanity of man' that constitutes 'the decisive political conflict in our culture' (*TO* 80). Stiegler and Nancy help us register the degree to which this conflict

itself depends upon the exclusion of a third term: the physical being of inorganic matter – an exclusion that founds the category of the biological.

Threshold (physical being)

> Every limit concept is always the limit between two concepts.
>
> Giorgio Agamben, *Homo Sacer*

As I have already suggested, the necessity, today, of including non-living being within the order of the biopolitical – and of opening biopolitics to its outside – is made particularly pressing by the research and development programme of nanotechnology, which seeks to fabricate nonorganic entities bearing those capacities for environmental stimulus and behavioural response that Heidegger ascribes to life, 'the kind of being that pertains to animals and plants' (*FCM* 191).

In order to 'exemplify the general structure of the environment proper to all animals', Agamben refers to the behaviour of a tick described by Heidegger's primary reference on animal behaviour, Jacob van Uexküll. As Agamben notes, the behaviour of the blind and deaf tick is entirely regulated by a very minimal array of sensory data, or 'carriers of significance': the sensitivity of its skin to light, the odour of butyric acid emitted by mammals, the temperature of 37 degrees celsius corresponding to that of mammalian blood, and the tactile properties of its prey's skin. The lifeworld of the tick described by van Uexküll consists entirely in the absorption of these sensory triggers, by which it locates and consumes the nourishment that it requires to reproduce before dying.[12]

It is precisely this sort of relation to an environment – the captivation of an entity by sensory disinhibitors – that scientists are attempting to engineer into polymers, bio-synthetic materials, and nano-scale sensors and actuators that are 'not without access to their environment'.[13] The procedure of nanoscience and technology is often to study structures and processes of organic life – such as viral architecture, bacterial self-replication, molecular self-assembly, and biological stimulus/response systems – in order to replicate those structures and processes in material contexts that are not confined by the cellular organization or the chemical requisites of the organism.[14] It is crucial to note that this research and development programme relies upon precisely the decoupling of a 'mode of being' from any *essential* determination by physico-chemical structure – precisely the decoupling for which Heidegger argues in his analysis of world. Nanotechnology studies the physio-chemistry of life in order to replicate the *phenomenon* of living being in 'non-living' matter.

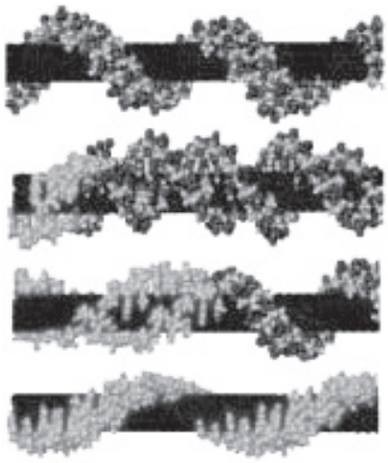
Minoru Taya, for example, director of the Center for Intelligent Materials and Systems at the University of Washington, characterizes biological systems as 'ideal adaptive structures with smart sensing capabilities'. 'The knowledge gained from studying biological mechanisms', he notes, 'are key input for designing adaptive structures and intelligent materials.' Among other things, Taya studies the principles of touch and light sensing in plants for their applicability to trigger, modify and control actuation mechanisms in intelligent materials, and he investigates the potential of artificial, polymer gel-based actuators as an alternative to biological, filament-based muscles.[15] But while Taya's research involves micro- and macro-scale materials, one application with the potential to link those larger-scale levels with nanoscale technology are the 'nano skins' designed by Pulickel Ajayan's research team at Rensselaer Polytechnic Institute.

Courtesy of Rensselaer/Yung Joon Jung

Nano-skins are flexible hybrid composite materials consisting of a polymer substrate embedded with organized arrays of carbon nanotubes – cylindrical tubes of hexagonally organized carbon atoms more than 10,000 times smaller than the diameter of a human hair. Since the composite membranes operate as field emitters, they are being developed as a template for flexible electronic devices. And because the nanotube arrays maintain their high conductivity and electrical sensitivity when embedded in the polymer, they could be used as adhesive structures, pressure sensors or gas detectors.[16] They also represent a promising step towards the sort of bio-mimetic sensors described by Taya, in so far as carbon nanotubes have the capacity to convert mechanical signals into electrical signals – one of the key functions of epidermal cells in plant and animal stimulus/response systems. As Ajayan has demonstrated with a research team at the University of Akron, nanotube arrays embedded in polymers can be used to mimic the action of microscopic sensory hairs on epidermal surfaces, which in the actuation

system of the Venus flytrap, for example, serve to carry mechanical stimuli to a receptor cell which then converts those stimuli into an electrical signal, propagating ion flow through neighbouring cells and activating the plant's motile action.[17] This bio-mimetic capacity of nanoskins is particularly notable when considered alongside the work of MIT engineers on macro-scale solid compounds that expand and contract through ion flow. Starting with compounds commonly found in lithium-ion rechargeable batteries, the MIT research team led by Yet-Ming Chiang and Steven Hall has developed prototypes of electrochemically actuated 'morphing materials' that offer 'a synthetic counterpart to the nastic actuation mechanism in plants'.[18]

The capacity of nanoscale materials to operate as mechanical sensors and electrochemical signals – and the potential of coupling of such sensors to actuation mechanisms – is also demonstrated by the DNA-wrapped carbon nanotubes engineered by Michael Strano's research team at the University of Illinois at Urbana–Champaign. The sensors designed by Strano's team consist of a strand of DNA wrapped around a single-walled carbon nanotube 'in much the same fashion as a telephone cord wraps around a pencil'.[19] Exposed to the ions of certain atoms, negative charges along the strand of DNA are neutralized, altering its shape and reducing its surface area. This shift perturbs the electronic structure of the carbon nanotube, altering its emission energy – a process that is reversed when the DNA is no longer exposed to such ions.



Courtesy of University of Illinois at Urbana–Champaign/Heller

Strano's team reports that 'the nanotube surface acts as the sensor by detecting the shape change of the DNA as it responds to the presence of target ions', and this response can be measured, enabling the detection of low concentrations of mercury ions in mammalian cells and tissues.[20] The project of researchers like Deborah Estrin, Founding Director of the Center for Embedded Networked Sensing at UCLA, is to integrate such nanoscale devices into 'massively distributed collections of smart sensors and actuators embedded in the physical world'. Such networks would not only operate both in and outside the bodies of that world's 'living inhabitants'; they would also have to function as 'self-configuring systems that adapt to unpredictable environments where pre-configuration and manual intervention are precluded'.[21]

It is not at all my intention to argue here that the entities fabricated by nanotechnology, nor the distributed networks into which they may eventually be embedded, are 'alive', nor that the category of 'life' should be expanded to include them. Nor is it incumbent upon my argument to demonstrate that such entities share 'the kind of being that pertains to animals and plants'. My argument, rather, is that *if* the 'way of being' called 'life' is to be determined as '*not without access* to what is around it and about it' (*FCM* 198), and *if* that way of being is to be delimited by the material object's 'not having access', then this determination and this delimitation are thrown into crisis by the entities that nanotechnology is in the process of fabricating.

Consider the threshold at which we are situated from the 'other side' of the limit concept – *access* – that is articulated by Heidegger as the limit between two other concepts, living and non-living being. If nanotechnology indicates a vector along which the material object attains access to its environment, Agamben relates a story about van Uexküll's tick that indicates a counter vector, along which the animal is effectively denied access to its world, deprived of any sensory stimuli in a modality of being similar to that of Heidegger's stone – while nonetheless remaining 'alive'. Agamben relays van Uexküll's brief reference to a certain tick that, in a laboratory in Rostock, 'was kept alive for eighteen years without nourishment, that is, in a condition of absolute isolation from its environment'. 'How is it possible', Agamben asks, 'for a living being that consists entirely in its relationship with the environment to survive in absolute deprivation of that environment' (*TO* 47). 'Perhaps', he conjectures, 'the tick in the Rostock laboratory guards the mystery of the "simply living being", which neither Uexküll nor Heidegger was prepared to confront' (*TO* 70). In other words, the isolated tick becomes Agamben's figure for 'bare life', the threshold state with which, as he argues in *Homo Sacer*, the biopolitical body of the West is now completely identified. In calling for a 'completely new politics', Agamben argues that 'this biopolitical body that is bare life must itself … be transformed into the site for the constitution and installation of a form of life that is wholly exhausted in bare life and a *bios* that is only its own *zoē*.' 'Today', he writes, '*bios* lies in *zoē* exactly as essence, in the Heideggerian definition of Dasein, lies (*liegt*) in existence' (*HS* 188).

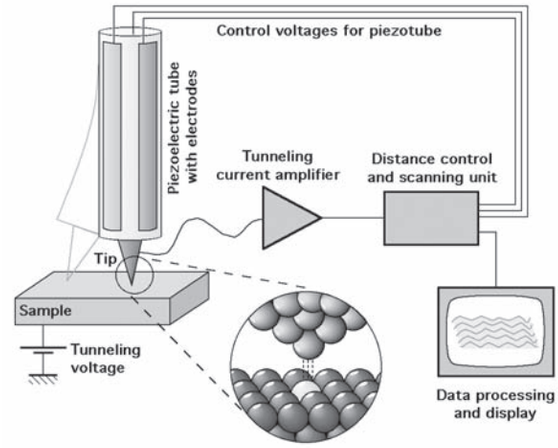
But in specifying that the tick can survive in its state of deprivation 'without, however, either ceasing to be an animal or becoming human' (*TO* 70), Agamben himself perhaps fails to confront the consequences of Heidegger's ontological schema for the condition of this biopolitical body, since the condition of 'not-having-access' would have to specify, precisely, the becoming-stone of the animal. As a non-living being, 'the stone', writes Heidegger, 'cannot be dead because it is never alive' (*FCM* 179). But the tick becomes, paradoxically, a stone that *remains* alive. It attains the state of non-living being, deprived of any and all *access* to its environment, yet nonetheless retains the capacity to die. The tick does indeed occupy the zone of indistinction where we find 'neither an animal life nor a human life, but only a life that is separated and excluded from itself' (*TO* 38). But the tick occupies this zone of bare life in the modality of non-living being. In fact, this utterly paradoxical being escapes any of the categories of stone, animal or man designated by Heidegger. In the becoming-animal or becoming-plant of the 'material objects' engineered by nanotechnology, and in the becoming-stone of the animal exemplified by the isolation of the tick in the Rostock Laboratory, Heidegger's triple thesis undergoes an implosion on the *outside* of the binary distinction between man and animal that Agamben deconstructs. And this outside is, of course, also the inside of that distinction, in so far as it is the ground upon which the *zoē* common to man and animal, and to all living beings, can be delimited in the first place.

'Every limit concept is always the limit between two concepts', we read in *Homo Sacer* (11). But what if, sometimes, a limit concept like *haplōs* being, or *the open*, were not the limit 'between' two concepts, but rather a limit traversing (at least) three, such as 'stone'/'animal'/'man'? Or in Agamben's terms: to include non-living being within the order of the biopolitical while thinking the site of biopolitical struggle beyond the frame of biological existence would be to expose bare life to its outside by thinking 'physical being' as a limit concept that includes *zoē* and *bios* as and along with 'material things'. How can we think physical *being* not as that being-without-access that Heidegger assigns to the stone, but rather as a threshold condition of 'all bodies, each outside the others' (Nancy, *SW* 63)? And how are we to articulate and position such a concept as conditioned by the incipient nanotechnological programme of 'designing a new material world'?[22]

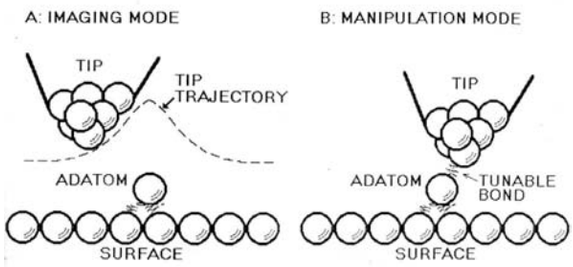
If the global distribution and integration of multi-scale sensor/actuator systems envisioned by the Center for Embedded Networked Sensing brings us to the limit at which the entire physical world is 'not without access' to itself, it may be one of the earliest enabling technologies of nanoscale research and fabrication, the Scanning Tunneling Microscope (STM), that most elegantly demonstrates the singular case of *sense* – the limit case of 'being-toward'. Moreover, it situates this limit precisely at an interface which Stiegler leaves unthought: not only that between 'man' and 'technical object' but *also* that between the technical object and the 'mere hunk of inert matter'.

The STM is capable of producing images of single atoms through a 'tactile' interface (since single atoms are too small to refract light). The basis for its operation is the quantum mechanical phenomenon of electron tunnelling, whereby an electron 'jumps' between two proximate atoms. When a tiny conducting needle, narrowing to a single atom at its tip, is brought into proximity with a conducting or semi-conducting surface, electrons 'tunnel' between the atomic tip and the atoms of the sample. A current can be established at this interface by applying voltage between the tip and the sample, and since the magnitude of that current is minutely sensitive to the distance between the two conductors, it can be used to establish a feedback loop that will adjust the position of the tip in accordance with the atomic topography of the sample. Mounted on a piezoelectric transducer that adjusts its height with finite control, the tip is scanned across a surface, rising or falling in accordance with the atomic terrain it encounters. As it moves, the position of the tip is measured and converted into a digitally mediated visual map of the sample's atomic structure. The STM can also operate in a positioning mode, whereby single atoms can be manipulated by the tip with exact precision.[23]

In the case of the STM, our 'access' to any information whatsoever about this particular environment is conditional upon the being-toward of two atoms and



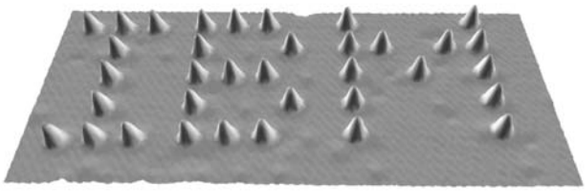
Courtesy of Institut für Allgemeine Physik



Courtesy of IBM Almaden Labs/Eigler

upon the being-between of the electrons exchanged through a network of surfaces. It is conditional upon the being-with of the interface. But in the first atomic positioning experiment in 1989, this profound evocation of 'the threshold of access' was used to inscribe the sign and seal of a multi-national corporation whose international business machines were instrumental to the administration of the biopolitical horrors analysed by Agamben in *Remnants of Auschwitz*.[24]

If the thirty-five xenon atoms used to spell I–B–M,[25] quivering at the threshold of sense, are the *non-living* harbingers of the 'unprecedented biopolitical catastrophe' of which Agamben warns in the final sentence of *Homo Sacer*, then what we require is a suturing of ontology to politics that would include their physical being as at once otherwise than living, otherwise than without access, and otherwise than 'merely' inert matter.



Courtesy of IBM Almaden Labs/Eigler

World without, non-living (nothing-otherthan-object)

> It is only in turning to stone that the threshold presences at all.
>
> Martin Heidegger, 'Language'

How can *physical being* be situated as a limit concept traversing at least three concepts – those demarcated by Heidegger as stone, animal and man? And how could the limit *of* physical being be thought as the open?

Even if world formation remains the exclusive privilege of 'the *Da-sein in* man' throughout his oeuvre, there are nonetheless indications in Heidegger's later work that are conducive to the construction of such a concept. Nanotechnology has become perhaps the most insistent technocultural signifier of what Heidegger, in 'The Age of the World Picture', calls 'the incalculable': the simultaneous appearance of 'the gigantic' and of a 'tendency toward the increasingly small' which signifies the limit of modern technology's 'autonomous transformation of praxis'. The incalculable, Heidegger writes, is 'that which, withdrawn from representation, is nevertheless manifest in whatever is, pointing to Being, which remains concealed'. If, however, the incalculable is the withdrawn index of Being itself – its 'invisible shadow' – it nevertheless remains the case that, within Heidegger's thinking, that which it indexes can only be accessed in its concealment by man, 'the shepherd of Being'. According to Heidegger, 'man will know, i.e., carefully safeguard into its truth, that which is incalculable, only in creative questioning and shaping out of the power of genuine reflection.'[26]

But one should remain alert to a significant tension inherent to the manner in which 'the power' of such 'genuine reflection' is figured in Heidegger's writing. In fact, the modality of man's being through which he is opened to world has less to do with questioning than with being-in-question, less to do with shaping than with being-shaped, and less to do with the power of genuine reflection than with a powerless exposure to exteriority. The rhetoric in which the world-forming capacity of man is described suggests that it involves a veritable becoming-object. If the stone is that which 'crops up here or there, amongst and amidst a host of other things', passively given over to the contingencies material existence, then man only attains access to world in so far as he approaches the threshold of this modality of being:

> That which is does not come into being at all through the fact that man first looks upon it, in the sense of a representing that has the character of subjective perception. Rather, man is the one who is looked upon by that which is; he is the one who is – in company with itself – gathered toward presencing, by that which opens itself. To be beheld by what is, to be included and maintained within its openness and in that way to be borne along by it, to be driven about by its oppositions and marked by its discord – that is the essence of man in the great age of the Greeks.[27]

The being spoken of here is neither an organism behaving in response to its 'own' environment, nor a reflective subject. It is an entity that is looked upon by that which is, borne along, driven about, and marked by discord. Heidegger says of the stone: 'if we throw it in the meadow then it will lie wherever it falls. We can cast it into a ditch filled with water. It sinks and ends up lying on the bottom' (*FCM* 197). Although the utterly callous 'comportment' of this scenario

is all too obvious, it is nevertheless this aggressive activity of subject that man must exchange for the passivity of the object before he will be gathered into the open. Agamben tells us that 'precisely because the world has been opened for man only by means of the suspension and capture of animal life, being is always already traversed by the nothing; the *Lichtung* is always already *Nichtung*' (*TO* 80). But here, at the very pivot of Heidegger's thinking of Being, it is not the suspension and capture of animal 'life' that opens world. Rather, world opens through the suspension and capture of 'man' by physical being.

Even if this is a strategically tendentious reading of this passage in Heidegger (since man 'is the one' through whom this suspension occurs), we can nonetheless recognize that 'the essence of man' and the opening of world is situated here *at* the threshold of physical being – the same threshold at which we found Agamben's tick, and at which, from the other side of 'access', Nancy situates the stone. And it is *within* this threshold that we encounter those 'incalculable' entities engineered by nanotechnology. *Through* this threshold, any entity whatever is exposed as other than itself, precisely in so far as it is nothing other than itself. The name that we will momentarily assign to this chiasmic threshold – at which an object is opened to world through its openness to other entities, and at which world is opened to any living entity in so far as it approaches the condition of the object – is *nothing-otherthan-object*.

Within the broadly Heideggerian frame in which we have been working, the question of physical being, qua being, is the question of how any entity whatever is traversed by the nothing. Nothing, for Heidegger, is that 'concealed essence of Being' towards which the invisible shadow of the incalculable points. In the penultimate appendix to 'The Age of the World Picture', Heidegger inscribes the following famous sentences:

> But Nothing as that Nothing which pertains to the having-of-being is the keenest opponent of mere negating. Nothing is never nothing; it is just as little a something, in the sense of an object [*Gegenstand*]; it is Being itself, whose truth will be given over to man when he has overcome himself as subject, and that means when he no longer represents that which is as object [*Objekt*].

We should take a moment to work through the obvious inadequacy of the English term 'object' to the distribution of Heidegger's German terminology in these formulations. Nothing is never something, 'in the sense of *Gegenstand*', and the truth of Being itself will be given over to man 'when he no longer represents that which is as *Objekt*'. While 'something' is given as the sense of *Gegenstand*, it is 'that which is' that is represented by the subject as *Objekt*. One might formulate the relation between these two senses of 'object' as follows: it is only in so far as it is *represented* as *Objekt* that 'that which is', for a subject, becomes *Gegenstand*; or, it is only in so far as Nothing is represented by a subject as an object that it appears to be something, which it *is not*. It is crucial to note here that it is not so much its ontological status that divides 'that which is' from the category of *Objekt*. Rather, it is the *representation* of 'that which is' as *Objekt* that divides the subject from the truth of Being by converting it into *Gegenstand* – an object for a subject.[28]

We can begin to follow the consequences of this logic towards a concept of physical being in its openness to world. Nothing is never *Gegenstand*, or that which man *represents* as *Objekt*, so Being itself will only be identified with Nothing as that which is other than 'something' or *Objekt*-for-a-subject. But in so far as it is 'never nothing', Nothing, or Being itself, is nothing other than *Objekt*, subtracted from its representation as such by a subject. Attempting to convey this complex conceptual nexus in English, one could therefore formulate the paradoxical relation of Being itself to the object in itself (*Objekt in sich*) as follows: that which is nothing other than object is Nothing, that which is other than 'object'. The concept that includes this irreducible duplicity – this immanent otherness of that which is never nothing and yet not something – could thus be named *nothing-otherthan-object*. This concept excludes *Gegenstand* from its referential field, and it therefore does not involve any *representation* by a subject of that which is as *Objekt*. Returning to the consequences of Heidegger's thinking of man in his essence as 'the one who is looked upon by that which is', we might then say that man overcomes him/herself as subject – ceases to *represent* that which is as object – precisely in so far as he/she becomes nothing-otherthan-object.

Thought as nothing-otherthan-object, the open transpires neither through the boundless life of the animal celebrated by Rilke's Eighth Duino Elegy, nor through man's 'power of genuine reflection', but rather through a projectivism proper to physical being, thought here as a category traversing stone, animal and man. That cognate of the open, Nothing – or Being itself – is nothing other than the otherness of objects to each other, and nothing other than the otherness of objects to identity. Such a conceptualization of physical being,

qua being, affirms Heidegger's thinking of Being as the opening of world, but it thinks the distribution of the opening of the ontological difference equally among all entities, such that any entity whatever, and every entity at once, is 'the shepherd of being'. Within a Heideggerian frame, nothing-otherthan-object thus operates as the limit concept we have been seeking. It specifies a threshold condition common to non-living, living and human being, and therefore passing between and through three categories as we find them in Heidegger: 'stone', 'animal' and 'man'. It specifies the suturing of any entity whatever to 'Being itself' as the threshold upon which it is open to world through its exposure to an outside. Such a concept does not imply that there is 'no difference' between discrepant types of entities. Rather, it affirms the difference in the modality of being of *every* entity, while recognizing differentiation itself as that 'essence' of physical being that is indifferent to any particular qualification of being-there.

Let me close by situating this concept, nothing-otherthan-object, more precisely in relation to Agamben's thinking of the biopolitical, of which this essay has been persistently critical. In *Homo Sacer*, Agamben calls for a suturing of ontology to politics that would think the 'space of exception in which a purely bare life, entirely controlled by man and his technology, appears for the first time' (*HS* 164). 'Biopower's supreme ambition', Agamben writes in *Remnants of Auschwitz*, 'is to produce, in a human body, the absolute separation of the living being and the speaking being, *zoē* and *bios*, the inhuman and the human – survival.' It is this 'essentially mobile threshold that, like the borders of geopolitics, moves according to the progress of scientific and political technologies'[29] that biopolitics attempts to track and to specify. But because in Agamben's discourse this mobile threshold is *never* situated precisely between living and non-living being, but only between variant concepts of life, or between life and death, it cannot specify the site at which power's 'supreme ambition' operates in the case of nanotechnology.

It has been my argument that nanotechnology forces us to confront a threshold at which non-living being is not-without-access, nor without world, and I have also argued that the projective opening of world through 'the *Da-sein* in man' itself occurs at the threshold of physical being. Nothing-other-than-object has been posited as a concept adequate to this sort of mobile threshold – one that does not only pass between life and death or man and animal, but that passes through and between the physical being proper to all entities in their being-there. Such a concept should not, however, be taken merely as a celebratory deconstruction of the Heideggerian schema stone/animal/man, or of Agamben's framing of biopolitics. It is intended, rather, as a constructive manoeuvre – positioned at once within and yet refractory to Heidegger's discourse on technology – towards a sombre reckoning with those contemporary operations of corporate technoscience that aspire to the absolute domination not only of bare life but of physical being: as nanotech enthusiast K. Eric Drexler puts it, to 'nearly complete control of the structure of matter'.[30]

An ethics and a politics capable of engaging this technoscientific horizon of the twenty-first century will have to think not only the biopolitical body of the West, but also the non-living sense of the world, or world without, non-living. The threshold of *haplōs* being at which that which appears is sutured to that which is – the very opening of world which power occludes and over which it attempts to exert control – cannot simply be conceived of as *zoē*, but has to be thought through physical being. For if physical being is what has always been excluded from the opening of world then this exclusion amounts to the closure of world and the failure of any effort to link politics with ontology. And if the first imperative of any ethics or politics is to think that which it excludes as the limit to which it must be addressed, the concept *nothing-otherthan-object* is posited here as a first step towards such a thinking. But it is only a first step, in so far as it challenges us to extrapolate from this aporetic limit within Heidegger's thought – and its contemporary redeployments – another approach to the inorganic open altogether.[31]

Notes

1. Giorgio Agamben, 'Absolute Immanence', in *Potentialities*, trans. Daniel Heller-Roazen, Stanford University Press, Stanford, 1999, p. 238.
2. *Critical Inquiry*, vol. 28, no. 1, Autumn 2001. The essays in Brown's special issue, along with some additional material, have been gathered into a book: Bill Brown, ed., *Things*, University of Chicago Press, Chicago, 2004.
3. See Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies*, Harvard University Press, Cambridge MA, 1999, and 'Why Has Critique Run Out of Steam? From Matters of Fact to Matters of Concern', *Critical Inquiry*, vol. 30, no. 2, Winter 2004, pp. 225–48; Graham Harman, *Tool-Being: Heidegger and the Metaphysics of Objects*, Open Court, Chicago, 2002, p. 216, and *Guerrilla Metaphysics: Phenomenology and the Carpentry of Things*, Open Court, Chicago, 2005. Latour's important article on matters of concern – and its eventual inclusion in Bill Brown's volume *Things* – provides an opportunity to address my decision in

this article to focus upon the term 'object' rather than 'thing'. This decision is particularly crucial given the extensive engagement with Heidegger that my conceptualization of the object involves. As Latour notes, 'all [Heidegger's] writing aims to make as sharp a distinction as possible between, on the one hand, objects, *Gegenstand*, and, on the other, the celebrated *Thing*.' 'What would happen', Latour asks, 'if we tried to talk about the object of science and technology, the *Gegenstand*, as if it had the rich and complicated qualities of the celebrated *Thing*?' (233). Suggesting that we consider all objects with the same 'enthusiasm, engagement, and complexity' that Heidegger reserves for his primary exemplar of *das Ding*, the jug, Latour argues that 'Heidegger's mistake is not to have treated the jug too well, but to have traced a dichotomy between *Gegenstand* and *Thing* that was justified by nothing except the crassest of prejudices' (234). But despite his desire to erase this dichotomy, Latour's rhetoric nonetheless preserves it by suggesting that while certain very complex objects (like dolomite, or Einstein's Patent Bureau electric coordination of clocks in Bern) demand treatment as Things, or gatherings, or matters of concern, other evidently less complex objects (a standard 'banal rock' [234]) are reducible to matters of fact. 'Things that gather cannot be thrown at you like objects', he writes. They are 'highly complex, historically situated, richly diverse matters of concern' (237). To my mind, this rhetorical decision leaves the English term 'object' unrecuperated, suggesting (like Heidegger) that only those objects which are sufficiently complex to be considered Things are worthy of philosophical attention. Thus, throughout this article, the term 'object' will be applied indifferently to 'banal rocks' and to the 'complex' objects fabricated by nanotechnology. The Heideggerian rumination on *das Ding* will be left aside entirely, since the issue here will be the recuperation of the self-difference and openness to world of any object whatever. The concept 'nothing-otherthan-object' that is developed in the final section of this article emerges rather out of Heidegger's differential usage of the two German terms *Gegenstand* and *Objekt*, whose discrepant denotation is elided by the English term 'object'. Nothing-otherthan-object constitutes an attempt to mark the physical being, qua being, of the object, in a manner that acknowledges the impossibility of 'representing', as a subject, that which is *Objekt*. See note 28, below.

4. Nadrian C. Seeman, 'Nanotechnology and the Double Helix', *Scientific American*, vol. 290, no. 6, 2004, pp. 65–75; Daniel A. Heller et al., 'Optical Detection of DNA Conformational Polymorphism on Single-Walled Carbon Nanotubes', *Science*, vol. 311, no. 5760, 2006, pp. 508–11; Steen Rasmussen et al., 'Transitions from Nonliving to Living Matter', *Science*, vol. 303, no. 5660, 2004, p. 936. See also Bernard Yurke et al., 'A DNA-Fuelled Molecular Machine Made of DNA', *Nature* 406, August 2000, pp. 605–8; and Andrew Turberfield, 'DNA as Engineering Material', *Physics World*, vol. 16, no. 3, March 2003, pp. 43–6. Carbon nanotubes are cylindrical tubes of hexagonally organized carbon atoms more than ten thousand times smaller than the diameter of a human hair. They can be 'grown' through induced self-organization in a laboratory. On the speculative performance of the 'already unfolding' future in what he calls 'nanorhetoric', see Colin Milburn, *Nanovision*, forthcoming from Duke University Press.
5. Geoffrey A. Ozin and André C. Arsenault, *Nanochemistry: A Chemical Approach to Nanomaterials*, Royal Society of Chemistry, Cambridge, 2005, p. 32.
6. Martin Heidegger, *The Fundamental Concepts of Metaphysics: World, Finitude, Solitude*, trans. William McNeill and Nicholas Walker, Indiana University Press, Bloomington, 1995, p. 177. Cited hereafter in text as *FCM*.
7. Akira Lippit, *Electric Animal: Toward a Rhetoric of Wildlife*, University of Minnesota Press, Minneapolis, 2000; Giorgio Agamben, *The Open: Man and Animal*, trans. Kevin Attell, Stanford University Press, Stanford, 2004). Derrida's seminar on 'The Beast and the Sovereign' took place at the University of California at Irvine, 2002–04. The seminar is as yet unpublished.
8. Agamben, *The Open*, p. 92. Cited hereafter in text as *TO*.
9. Giorgio Agamben, *Homo Sacer: Sovereign Power and Bare Life*, trans. Daniel Heller-Roazen, Stanford University Press, Stanford, 1998. Cited hereafter in text as *HS*.
10. Bernard Stiegler, *Technics and Time, 1: The Fault of Epimetheus*, trans. Richard Beardsworth and George Collins, Stanford University Press, Stanford, 1998. Cited hereafter in text as *TT*. Jean-Luc Nancy, *The Sense of the World*, trans. Jeffrey S. Librett, University of Minnesota Press, Minneapolis, 1997. Cited hereafter in text as *SW*.
11. Martin Heidegger, *Being and Time*, trans. John Macquarrie and Edward Robinson, HarperCollins, San Francisco, 1962. On anticipation, see paragraphs 61 and 62. On falling and thrownness, see paragraph 38.
12. Van Uexküll's description of the tick's *Umwelt* is quoted by Agamben in *The Open*, p. 46.
13. Sarah Tomlin defines such so-called 'smart materials' in a manner that precisely evokes Heidegger's determination of living being as 'not without access' to an environment by which it is bound in captivation: 'To qualify as truly "smart", a material has to sense changes in its environment and respond to them in an appropriate way. It must also do this reliably, over and over again.' See 'Getting to Grips with Smart Materials', *Nature: Materials Update*, April 2002, www.nature.com/materials/news/news/020404/portal/m020404–4.html (accessed 15 May 2006).
14. On the rhetoric of 'postbiological life' and of the 'postvital' that accompanies nanotechnology's disintegration of the organism, see Colin Milburn, 'Nano/Splatter: Disintegrating the Postbiological Body', *New Literary History* 36, 2005, pp. 283–311.
15. Minoru Taya, 'Bio-inspired Design of Intelligent Materials', *Smart Structures and Materials 2003: Electroactive Polymer Actuators and Devices*, July 2003, pp. 54–65.
16. Yung Joon Jung et al., 'Aligned Carbon Nanotube-Polymer Hybrid Architectures for Diverse Flexible Electronic Applications' *Nano Lettters*, vol. 6, no. 3, 2006, pp. 413–18.
17. Taya, 'Bio-Inspired Design', pp. 54–5.
18. Yukinori Koyama et al., 'Harnessing the Actuation Potential of Solid-State Intercalation Compounds', *Advanced Functional Materials* 16, 2006, p. 498. The authors note that such materials 'could enable generalized, large-scale structural actuation, future applications of which could include shape-morphing hulls and wings for air and water vehicles, robotics, and other 'smart' or adaptive structures' (492).

19. University of Illinois at Urbana-Champaign, 'DNA-wrapped Carbon Nanotubes Serve as Sensors in Living Cells', *Science Daily*, 27 January 2006, www.sciencedaily.com/releases/2006/01/060126195041.htm (accessed 20 May 2006).
20. Daniel A. Heller et al., 'Optical Detection of DNA Conformational Polymorphism on Single-Walled Carbon Nanotubes', *Science*, vol. 311, no. 5760, 2006, p. 510.
21. See the Center for Embedded Network Sensing homepage at http://research.cens.ucla.edu/portal/page?_pageid=59,43783&_dad=portal&_schema=PORTAL.
22. Gregory B. Olson, 'Designing a New Material World', *Science*, vol. 288, no. 5468, May 2000, pp. 993–8.
23. One of the clearest descriptions of the STM and its applications is provided by Charles Lieber in 'Scanning Tunneling Microscopy', *Chemical & Engineering News*, April 1994, pp. 28–43. On atomic positioning, see Don Eigler, 'From the Bottom Up: Building Things with Atoms', in Gregory Timp, ed., *Nanotechnology*, Springer Verlag, New York, 1999, pp. 425–35.
24. See Edwin Black, *IBM and the Holocaust*, Three Rivers, New York, 2002.
25. On the fabrication of the atomic IBM logo, see D.M. Eigler and E.K. Schweizer, 'Positioning Single Atoms with a Scanning Tunneling Microscope', *Nature* 344, 1990, pp. 524–6.
26. Martin Heidegger, 'The Age of the World Picture', in *The Question Concerning Technology*, trans. William Lovin, Harper & Row, New York, 1977, pp. 135, 116, 154, 135–6; The Turning' in ibid., p. 42.
27. Ibid., p. 131.
28. Such a reading of the relation between the concepts *Gegenstand* and *Objekt* corresponds with Dominique Pradelle's assessment of their Kantian distribution, such that *Gegenstand* signifies the phenomenal object of appearance and *Objekt* signifies the noumenal thing-in-itself. My reading of Heidegger's formulations intends to be rigorously, if perhaps counter-intuitively, true to this conceptual distribution: if it is *Objekt* that signifies the thing-in-itself, it is the *representation* of the thing-in-itself *as Objekt* that converts it into an object for a subject, or *Gegenstand*. See 'Gegenstand/Objekt', trans. David Macey, from *Vocabulaire Européen des Philosophies: Dictionnaire des Intraduisibles*, ed. Barbara Cassin, in *Radical Philosophy* 139, September/October 2006, pp. 21–31.
29. Giorgio Agamben, *Remnants of Auschwitz: The Witness and the Archive*, trans. Daniel Heller-Roazen, Zone, New York, 1999, pp. 155–6.
30. K. Eric Drexler, 'Machines of Inner Space', in *Nanotechnology Research and Perspectives: Papers from the First Foresight Conference on Nanotechnology*, ed. B.C. Crandall and James Lewis, MIT Press, Cambridge MA, 1992, p. 326.
31. This article is drawn from the first chapter of a dissertation project entitled 'The Materials: Technoscience and Poetry at the Limits of Fabrication', which attempts to construct the conditions of such an approach.