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## Digital Materiality, Morphogenesis and the Intelligence of the Technodigital Object

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There can only be a simultaneous genesis of matter and intelligence.

Gilles Deleuze, *Bergsonism*

The robot does not exist.

Gilbert Simondon, *On the Mode of Existence of Technical Objects*

We have entered a new object landscape. We now inhabit an *objectscape* populated by intelligent things made of carbon and silicon, databytes and neurons, where the mineral, the technical and the social intermix.<sup>1</sup> Our interaction with digital devices prompts questions about the boundary between organic nervous systems and electronic circuits, between the born and the manufactured, between the organic and the inorganic. Equally under question are the boundaries of the technodigital object *per se*. I refer to any of the hand-held devices we engage with daily: all the smartphones, tablets and PDAs that have become our companions. Taken together these devices generate a pulsating *objectscape* with no fixed borders where new forms of intelligence emerge and new types of agency are performed. An entity gone blurry by velocity, the digitally distributed, open-ended technodigital object merges any distinction still standing between hardware, software and interaction.<sup>2</sup> It does so by becoming whatever it is running (an app, a program, a stream of data) at any given moment. The convergence of hardware, software and interaction engenders a kind of highly immersive, sensory and somatic experience: a new assemblage of multiple material intelligences, not necessarily and not exclusively human.

This chapter investigates these new assemblages from the specific viewpoint of their materiality. It suggests that the status of contemporary technodigital objects should be rethought on grounds of their materiality and the forms of intelligence this materiality expresses. Some key

with Félix Guattari – are deployed to unpack the argument of the materiality of the technodigital object: the transition from object to *objectile*; a morphogenetic account of matter; and the implications of a radical material vitalism for the way design approaches technodigital objects. Particular relevance is given to Deleuze and Guattari's thought that matter is to be apprehended via intuitive and inquisitive forms of knowledge. This serves as a springboard to suggest a new research frame for design based around problem finding, rather than problem solving. The insights gathered are then utilised to investigate the silicon-based materiality of the technodigital object.

Key to an understanding and reframing of our relationship with the current incarnation of the technodigital object is what Deleuze wrote in *The Fold* concerning the transition from object to *objectile*. It was between the late 1980s and the early 1990s, when Deleuze was occupied with these ideas, that the World Wide Web and the programme of mass digitalisation as we now know them were taking hold globally. Since then, our relationship with intelligent machines has become more complicated, our entanglement with this wondrous techno-landscape posing more and more questions about what counts as human in the digital era. A full discussion of such an entanglement is beyond the scope of this chapter. Instead, its focus is upon a specific aspect of the technodigital object: the intelligence of its materiality at once processual and designed, and how to design for this material intelligence.

Indeed, important implications of the changes in the status of the object concern design. As objects mutate, then the process of design must be rethought to account for such changes. Design is defined here as a process that is *simultaneously* of thing-making and of meaning-making. This process always concerns the near future, what has not happened yet, but *might* happen. A model of material variability based on morphogenesis is proposed to make sense of this process and its outcomes, to unfold design's innate propensity into the 'not yet', its own material becomings. Thus, it is argued that design should be rethought *morphogenetically*. According to this perspective form emerges from the continuous variability of matter, rather than being imposed on it by an external agency: this is the morphogenetic model. Morphogenesis is understood as the key theory that explains the emergence not just of individuated form but of thoughts and practices too, specifically those circulating around the technodigital object. This is to say that thoughts and practices, like form, emerge by the interplay of continuity and variability, rather than being imposed by a blueprint.

and practical philosophy and radical, vital, molecular materialism that takes matter as self-organising and emergent, must impact on some of the discourses currently circulating within the theory and practice of design. A morphogenetic perspective on matter forces design to question how objects actually come to exist, and in broader terms, design's own relationship with materiality. By rethinking design *through* Deleuze, the chapter shows how some of this philosophical corpus might steer design into rethinking some of the key principles it takes for granted. For instance, a morphogenetic perspective, by questioning the hylomorphic form-matter coupling, takes apart the convention of the relationship between form and function. The transition from object to *objectile* reframes the notion of object, and consequently the role of the user-subject. Here an investigation of the technodigital object may reveal how design's insistence on the centrality of the user needs a reappraisal.<sup>3</sup> As the object becomes an open-ended, relational, intelligent event, so the user-subject is shifting accordingly.

Thus, the proposed conceptual framework for design research is based on an argument against both the hylomorphism and the teleological fixation with form and function that still intoxicate ways of thinking about – and consequently of practising – design and technology. For instance, a matter-based understanding of the technodigital object casts a new light on the discourses on dematerialisation. It questions the dichotomy between the tangible and the intangible that often supports them. Dematerialisation's double claim for invisibility and immediacy obscures the indisputable material reality of the complex and messy infrastructure any digital performance depends upon. As sociologist Jennifer Gabrys points out, digital technology is framed by the twin technoscientific 'spectres of virtuality and dematerialization' (2011: 4), with the result that the materiality of our always-on status is seldom, if ever, acknowledged. The paradigm of dematerialisation is thus not only highly problematic, but also misleading. By disregarding the materiality of the digital – the circuit boards, copper wires, optic fibres, cables, radio masts, servers warehouses, minerals and, fundamentally, the silicon – that collectively makes possible our increasingly naturalised digital experiences, the paradigm of dematerialisation culturally dominates by means of invisibility. A morphogenetic perspective, on the other hand, leads us straight into the core of the materiality upon which our digital world is based.

Design must confront these questions by taking on board and examining in their discourses, practices and processes what radical material-

rethink the design processes that enable the existence of technodigital objects, their performance, efficiency and their effects of subjectivity, we must begin from a morphogenetic understanding of their materiality. This position allows a deeper understanding of the affective and somatic investments at stake in the programmable and computational devices we currently engage with.

Some of the questions this chapter addresses are: What is the contribution of Deleuze to an assessment of the technodigital object? What does it mean for design to take into account, practically and experimentally, a morphogenetic perspective and matter's own capacity to spontaneously self-organise? How does this impact on, and affect, the way the technodigital object is designed?

The chapter is divided in two parts. The first part draws on Deleuze's *objectile* and uses the shift from object to event it portrays to analyse the status of the technodigital object. The argument is that for this shift to be understood in its currency, a morphogenetic model must be made explicit, with its embedded critique of hylomorphism. Deleuze and Guattari's distinction between Royal and nomadic science is drawn upon to reinforce this critique. They write that if matter is a flow, then it can only be followed. To follow matter is to apprehend material variability via intuition. Intuition, it is argued, is what can allow design to put morphogenesis at its core and to shift its remit from problem solving to problem finding. This means for design to be engaging with a complexification – rather than a reduction – of the existent, in other words, to move away from the conventions of problem solving.<sup>4</sup> The extent to which material variability affects processes of form-making cannot but impact profoundly on the way design is conceptualised.

The second part of the chapter takes a different approach. The technodigital object is examined through Deleuze's image of a sieve or a membrane that, stretched over chaos, makes possible the emergence of individuation (Deleuze 1993). I take this individuated outcome as an appropriate description of an open-ended relational object in its technodigital form, namely the interface. The ontological status of the technodigital object is then examined by investigating its silicon-based materiality. The argument positions the technodigital object as a material intelligence developing and unfolding morphogenetically, thus contesting the cultural discourse of dematerialisation. It then looks at the ways hand-held digital mobile devices are reshaping what constitutes a designed object and, as a consequence, what constitutes a user or subject. Digital devices are taken here as the tangible encounter between

By 'following' the paths of materiality and metallurgy (Deleuze and Guattari 1988: 451) we plunge into the main constituent of the microchip: silicon. Silicon is investigated as the main constituent of our digital assemblages and the essential component of our digital world. Deleuze's prophetic 'revenge of the silicon' (2006: 178) is drawn upon to chart the rise and dominance of this material in our era. Silicon's supremacy is beginning to be questioned, however, by a new breed of microchips that emulate neural activity: *neuromorphic* chips (Simonite 2013; Talbot 2013; Hof 2014; Monroe 2014). Neuromorphic chips bypass the distinction between carbon and silicon, and articulate new forms of material intelligence. This convergence of silicon and carbon, of organic and inorganic, is brought back to a philosophical examination through a concluding assessment of Deleuze's concept of nonorganic life (Deleuze 2001). Concepts harvested from the work of design theorist Benjamin Bratton (2002, 2008, 2009, 2013), architecture theorist Sanford Kwinter (1992, 1998, 2001, 2007), and philosopher Manuel DeLanda (2004, 2009) further populate these reflections.

## Part 1

### *From object to event*

The object, writes Deleuze, has a new status. No longer confined within the mould that has created it, it has become an event continually modulated in time. 'This new object we can call *objectile*', Deleuze states in *The Fold*, continuing:

As Bernard Cache has demonstrated, this is a very modern conception of the technological object: it refers neither to the beginnings of the industrial era nor to the idea of the standard that still upheld a semblance of essence and imposed a law of constancy ('the object produced by and for the masses'), but to our current state of things, where fluctuation of the norm replaces the permanence of the law; where the object assumes a place in a continuum by variation; where industrial automation or serial machineries replace stamped forms. The new status of the object no longer refers its condition to a spatial mold – in other words, to a relation of form-matter – but to a temporal modulation that implies as much the beginnings of a continuous variation of matter as a continuous development of form. (Deleuze 1993: 19)

Deleuze refers here to the evolution of the technical object. He also, to an extent that is perhaps not always fully appreciated, addresses

the traditional design technique of form-making, and by projecting it into temporalities of perception where it disaggregates and recomposes into the pulsating intensities of pure modulation. The designed, man-made object is positioned on a fractured timeline, where what counts is no longer a 'spatial mold' (form-matter), but a 'temporal modulation' (formation). As form becomes formation, object becomes event.

In our daily interaction with digital devices we no longer deal with objects but with events. This transition from object to event is framed historically as a shift from moulding to modulation. It takes place when the object is no longer withdrawn from the mould that forms it, but expresses the continuous variation of a morphing and mobile matter. The object ceases being the fixed representation of a relation between matter and form to become instead the temporal expression of an event-affect continuum, that is, the active and affective dynamism that permeates matter. The implications for the technodigital object are clear. The permanently connected, programmed and plugged-in environment we inhabit through our interaction with technodigital objects takes shape through a process of continuous modulation. Although we may call it 'environment', this is not a space. As Kwinter (2007) points out this is not where but *when* our attention is captured and held. This experience is evoked by Bratton (2009) when he describes the inertial mobility of the archetypal Los Angeles event of being stuck in gridlocked traffic whilst simultaneously being connected, and sucked in by an absorbing *elsewhen* made of checking, updating, emailing, browsing, scrolling.

Deleuze's insight offers a frame of analysis that will be deployed in the second part of the chapter. What need to be further investigated now are the implications of a morphogenetic model of matter for the technodigital object and for design.

### *Slices of intelligent matter*

Variouly defined as matter-flow, matter-movement and matter-energy, the 'unorganized, nonstratified, or destratified body and all its flows: subatomic and submolecular particles, pure intensities, prevital and prephysical free singularities' (Deleuze and Guattari 1988: 43), is what Deleuze and Guattari call 'the prodigious idea of *Nonorganic Life*' (1988: 411). Here 'the essential thing is no longer forms and matter, but forces, densities, intensities' (1988: 343). This self-organising, spontaneously shifting matter, traversed by flows of nonorganic intensities, has its philosophical roots in the thought of Baruch Spinoza. Spinoza's

manifests itself actively in the world through its capacity of producing and being produced according to a non-hierarchical and un-mediated dynamics (Hardt 1993). It is a substance that does not precede its attributes, a cause that does not precede its effects, a whole that does not precede its parts. It is a process and production with no beginning or end. It is a process through which difference keeps on generating itself (Montag and Stolze 1997). With this singular and remarkable substance Spinoza shifts his philosophical project from metaphysics to physics. Everything that other philosophies invest in a variety of god(s), Spinoza locates in this inherent capacity of things to produce. Thus, Spinoza's is a 'metaphysics of the producing force' (Matheron 1998: 14), opposed to classic metaphysics that subordinates the productivity of things to a transcendent order. Intended in this way, matter possesses both the power of affecting and of being affected. Matter is therefore both production and sensibility. It has intelligence. Each and every body, each and every thing, organic or nonorganic, living or non-living, animated or inanimate is therefore, from this perspective, a slice of intelligent matter traversed by intensities.

Drawing on Spinoza, Deleuze and Guattari's materialism postulates that all things are formed through differentiation and individuation of the same substance, and that matter vibrates with the potential of its creative evolution and innovation.<sup>5</sup> Infinite permutations are seen through a relational world-view where the human and the non-human, the sub-personal and the molecular ceaselessly combine and recombine through a myriad of rhizomes, assemblages and machines. In this relationality what counts are relationships 'with neither object nor self' (Deleuze 2001: 26), the forms that matter might or might not take in its recombinations. Matter is a dense, non-subjective and affirming force. What counts, then, is not subject or object, form or matter, structure or attributes, but the 'silent dance' of forces, intensities and the most disparate things. In this dance 'a semiotic fragment rubs shoulders with a chemical interaction, an electron crashes into a language, a black hole captures a genetic message, a crystallization produces a passion, the wasp and the orchid cross a letter' (Deleuze and Guattari 1988: 77).

Deleuze and Guattari state repeatedly how on this plane of immanence 'peopled by anonymous matter, by infinite bits of impalpable matter entering into varying connections ... it is a question not of organisation but of composition: not of development or differentiation, but of movement and rest, speed and slowness' (1988: 282). These relations of movement and rest, speed and slownesses take place

Guattari describe as 'haecceities, affects, subjectless individuations that constitute collective assemblages' (1988: 294). The inanimate and the animate, the natural and the artificial, the living and the non-living, the organic and the nonorganic are found here, no distinction among them. This is the 'unnatural participation' (1988: 267) that takes place in the making and unmaking of the plane of composition, where different things are all expressions of the same material substance in becoming. We are in the Spinozistic plane of immanence, a plane of proliferation and contagion where *haecceities*<sup>6</sup> predating any categorical determination keep on emerging, combining and dissolving. Here we also find the various assemblages of silicon and carbon into which this chapter will probe.

This radical materialism allows us to theorise the technodigital object and its transformations, while staying clear of the hylomorphic model. This is because one of the key implications of this radical materialism is that the categorical distinction between matter and form is uprooted. Instead, we move *beyond* matter-form: 'the *material-force* couple replaces the *matter-form* couple' (Deleuze 2006: 160). What is important for design is precisely this shift: how material variability offers a radical alternative to the hylomorphic model (DeLanda 2004, 2009). What is also important here is the extent to which this analysis can have an impact on how technodigital objects are designed and experienced. Before proceeding any further let us examine more closely what the hylomorphic model implies, and why it is necessary for design to move forward.

### *Beyond hylomorphism: for an intuition-driven nomadic design*

The hylomorphic model assumes an external agency acting upon a matter seen as fundamentally passive and inert. It therefore presupposes homogeneity of matter and organisation of form. It also implies that matter is imbued with non-material properties. As Deleuze and Guattari remind us in *A Thousand Plateaus*, it is French philosopher Gilbert Simondon who 'exposes the technological insufficiency of the matter-form model, in that it assumes a fixed form and a matter deemed homogeneous' (Deleuze and Guattari 1988: 450). Simondon shows how the hylomorphic model, by assuming that form and matter are two distinct and separate entities, cannot adequately account for the active and affective dynamisms that permeate matter, the 'ambulant coupling

In an essay on morphogenesis, form-making and Umberto Boccioni's futurist paintings, Kwinter explains further the limitations of hylomorphism, which is unable to account for the genesis of form 'without recourse to metaphysical models' (1992: 53). For Kwinter, this 'perennial misunderstanding' has cast its shadow on the modern western scientific tradition 'because it lent itself well to reductionism and controlled quantitative modelling' (1992: 53).<sup>7</sup> It is only with topology that the qualitative transformations that a system undergoes can be captured and analysed as transformational events happening in time. From a topological perspective the relationship matter-form is postulated as an encounter of divergent forces. Form emerges from a process of morphogenesis, rather than being imposed by an external blueprint, ideal, or agency. Anthropologist Tim Ingold gives an example of this process by offering an alternative reading of the process of brick making. If brick making is usually seen as a typical example of the moulding process, Ingold thinks otherwise:

The brick, with its characteristic rectangular outline, results not from the *imposition* of form onto matter but from the *contraposition* of equal and opposed forces immanent in both the clay and the mould. In the field of forces, the form emerges as a more or less transitory equilibration. (Ingold 2013: 25)

The idea of objects emerging as events produced by the encounter of different forces is underpinned by a consideration of matter as, and in, continuous variation. As matter coalesces and disaggregates, changes of states take place, thresholds of intensities are reached at various speeds, and forms unfold, not as fixed things, but as 'continuous metastable events'. 'Forms are always new and unpredictable unfoldings shaped by their adventures in time' writes Kwinter (Kwinter 1992: 59). Time releases the forms present in matter as virtualities yet to be actualised.<sup>8</sup> Matter is thought of in terms of events and processes, rather than things and objects.

This material vitalism, where all matter possesses an immanent power – a material 'esprit de corps' (Deleuze and Guattari 1988: 454) – sets free what the hylomorphic model conceals. It also paves the way for a reappraisal of objects through an equally radical material vitalism. The material combination of energy and movement, together with the intensities liberated in their topological deformations, constitute a flow of material variation that, as we shall see in the second part of this chapter, is particularly apt to describe the current technodigital object and its evolution. For the moment, it is worth quoting Deleuze and Guattari at

On the one hand, to the formed or formable matter we must add an entire energetic materiality in movement, carrying *singularities* or *haecceities* that are already like implicit forms that are topological, rather than geometrical, and that combine with processes of deformation: for example, the variable undulations and torsions of the fibers guiding the operation of splitting wood. On the other hand, to the essential properties of matter deriving from the formal essence we must add *variable intensive affects*, now resulting from the operation, now on the contrary making possible: for example, wood that is more or less porous, more or less elastic and resistant. At any rate, it is a question of surrendering to the wood, then following where it leads by connecting operations to a materiality, instead of imposing a form upon a matter: what one addresses is less a matter submitted to laws than a materiality possessing a *nomos*. One addresses less a form capable of imposing properties upon a matter than material traits of expression constituting affects. (Deleuze and Guattari 1988: 450)

There are two important points to make here. First, the form-making process has to do with energy and movement. Drawing on Simondon, Deleuze and Guattari identify an intermediary zone of 'energetic molecular dimension' between form and matter, 'a space unto itself that deploys its materiality through matter, a number unto itself that propels its traits through form' (1988: 451). Again, this is where we find the 'ambulant coupling *events-affects*' which points us towards a new way of investigating the mobile intensities characteristic of our *objectscape*.

Secondly, if matter is a flow, then it 'can only be followed' (1988: 451). The idea that matter can only be followed is one of the key implications of the morphogenetic model. It opens up to a resiliently matter-led approach to design.<sup>9</sup> But what does it mean to 'follow matter' in practice? Deleuze and Guattari are explicit on this point. To follow matter, they say, is 'intuition in action' (1988: 452). Their distinction between Royal and nomadic science is useful to establish this point. They write:

Royal science is inseparable from a 'hylomorphic' model implying both a form that organizes matter and a matter prepared for the form; it has often been shown that this schema derives less from technology or life than from a society divided into governors and governed, and later, intellectuals and manual laborers. What characterizes it is that all matter is assigned to content, while all form passes into expression. It seems that nomad science is more immediately in tune with the connection between content and expression in themselves, each of these two terms encompassing both form and matter. Thus matter, in nomad science, is never prepared and therefore homogenized matter, but is essentially laden with singularities (which con-

from pertinent traits (which constitute a matter of expression). (Deleuze and Guattari 1988: 407)

Royal science focuses on linear behaviour in states of equilibrium and is concerned with formal laws imposed on inert matter from the outside. While Royal science deals therefore with matter-form and consists chiefly in 'reproducing', nomadic science concerns material-forces and deals with 'following' (1988: 410). The 'reproducing' has to do with iteration; 'following' has to do with itineration. The distinction is clearly between Royal science's reproduction and permanence of an established viewpoint, and nomadic science's search for singularities and intensities through the practice of following.

It is important to note that this nomadic, following, itinerant mode through which material variability can be apprehended is 'inseparable from a sensible intuition of variation' (1988: 407). It is only through intuition that matter can be apprehended in all its variability (Deleuze 1991). Thus, intuition is the best possible way of knowing a matter populated by '*vague and material* essences' that are 'vagabond, anexact and yet rigorous' (Deleuze and Guattari 1988: 449). What distinguish these vagabond essences from 'fixed, metric and formal' ones are the two qualities of *vagueness* and *fuzziness* (1988: 449). Again, matter is revealed in its traits, which are neither formal nor formed, but indeterminate, vague, fuzzy. Intuition operates precisely via this indeterminacy, by its coupling with the vagueness of events through which individuation takes place. It is through this intuition-driven process that objects emerge. Objects come to exist not out of a predetermination, as a compound of matter and form, but as the outcome of the continuity and variation of matter captured as a specific type of individuation: the *event*.

Commenting upon Henri Bergson's notion of intuition, philosopher Elizabeth Grosz observes that intuition is a method for 'the discernment of differences' (2011: 50).<sup>10</sup> In Grosz's account, intuition is defined as:

a mode of 'sympathy' by which every characteristic of an object (process, quality, etc.) is brought together, none is left out, in a simple and immediate resonance of life's inner duration and the absolute specificity of its objects. It is an attuned, noncategorical empiricism, an empiricism that does not reduce its components and parts but expands them to connect this object to the very universe itself. (Grosz 2011: 48)

This notion of intuition as a mode of sympathy among objects suggests that intuition belongs to a cosmic way of apprehending the world whereby things resonate with each other and are grasped in ineffable

that is 'dependent upon sensitive and sensible evaluations that pose more problems that they solve' (Deleuze and Guattari 1988: 412).

Here we reach, via intuition, a key idea to deploy to rethink design. As intuition counteracts categories, embraces vagueness and can only proceed by following material variation, it produces a knowledge grounded in a sensitivity to posing problems, rather than in a drive to find solutions. This is an important theoretical point, as it puts forward a shift for design from problem solving to *problem finding*. It proposes to stop thinking about design as a process of finding the solution to a problem – a rational interpretation that evaluates design outcomes solely in terms of efficiency and performance – to think instead about design as a problem-finding enterprise.

On the one hand, design as problem solving is a task-oriented, performance-measured, linear exercise that reduces uncertainty. It is based on a conventional view of design as a technology of affective capture that enforces and reproduces market ideologies (Marenko 2010). On the other hand, design as a problem finding activity has to do with an increase in complexity, a problematisation of the existent, and a development of a material sensitivity *via* design. As an agent of problematisation design becomes an intuitive, material, sensitive-rich enterprise, more akin to a *nomadic, minor* science than to a Royal science. It is a design that follows and produces minoritarian lines of creation and inventiveness: a *minor* design.

What Deleuze writes in *Bergsonism* is useful here: 'in philosophy and even elsewhere it is a question of *finding* the problem and consequently of *positing* it, even more than solving it' (1991: 15). For Deleuze positing a problem concerns invention rather than discovery. This is because discovery is always the unveiling of something that *already* exists. Invention concerns instead the creation of the terms by which a problem will be stated. To reposition design as a problem-finding activity means therefore to embrace the idea that problems have no given solution. Instead, problems must generate their own solutions by a process through which what did not exist – what might never have happened – is invented. We are fully in the realm of the virtual (Marenko 2016b).

The relevance of these ideas for design is clear. By engaging with hylo-morphism design remains trapped in a matter-form paradigm, forced to reproduce the existent through a problem-solving apparatus based on retrofitting. On the other hand, by grasping matter from a morphogenetic perspective, and by apprehending its variability through intuition, design is free to develop a new approach based on developing material

inventive, creative and problematising knowledges that are minor and nomadic.

## Part 2

Next I will examine another aspect of the dynamism inherent to matter. It concerns the ways in which the morphogenetic perspective articulates the material intelligence of the technodigital object. It looks at the encounter of different intelligences from the perspective of their materiality. It takes silicon as the entry point into the materiality of the technodigital object. Silicon is approached with a twofold perspective: first, by drawing on Deleuze's brief commentaries on the regime of silicon (Deleuze 1988b; 2006); then, by looking at the impending demise of silicon-based computation. New frontiers of computation beyond silicon such as neuromorphic chips are presented in order to speculate on the convergence of silicon and carbon. This section concludes by putting forward some insights on what this convergence may mean for the design of interactive, intelligent, increasingly alien, technodigital objects.

### *Interfaces, events and blending*

Design theorist Benjamin Bratton (2002, 2013) takes the interface as the dominant material discourse of our times.<sup>12</sup> The interface is the object that visibly manifests the cloud-based surges of data streaming incessantly towards the user. The interface is the hinge of the user-device assemblage. By bringing together the human sensorium and electronic sensors, the interface mediates the encounter of two different intelligences: the human and the digital. This mediation between user and cloud engenders our contemporary experience of digital devices, where the omnipresent two-dimensional screen has become familiar to the point of naturalisation. However, far from being a benign or neutral technology of mere translation of information, the interface is a programmed *mode* of relating to technology. Design theorist Branden Hookway (2014) compares the interface to a mirror. In the same way in which we encounter our own mirror image always before encountering the mirror, similarly the interface is already there – a given threshold, quietly merging into the background – at the moment when interaction takes place. The naturalisation of the interface, which masquerades its agency under the double cloak of transparency and immediacy, generates a peculiar situation where the user is not fully aware of what is

the extent to which the user is being *designed* by this specific form of technology.

Hookway's use of the notion of *daimon* or *numen* to discuss the interface is useful here. In ancient Greek the *daimon* – and its Latin equivalent *numen* – was a divine being or spirit mediating the uncertain territory between spiritual and material worlds. The *daimon* has to do with 'the spiritual identity of a material thing, its proliferation or procreation, and the animation of inanimate things' (Hookway 2014: 82). *Daimons* reside in some objects and not others, especially in threshold objects, for instance household items charged with performing guardian duties. Hookway likens the interface to a locus inhabited by the *daimon* to stress the animation and indeterminacy of intelligent matter.

Similarly, in discussing the 'app', Bratton describes this particular interface as a 'thin membrane on top of a vast machine . . . the intersection point between two far more complex reservoirs of intelligence: the intentional user and the Cloud infrastructure upon which the little app is perched' (2013: n.p.). Bratton invites us to rethink what constitutes an app: a 'blended co-programming of space and software'. This 'blending' has become, says Bratton, the scope of design, now operating on this membrane/surface of mediation. Every time the material interface of our hand-held digital device is touched, clicked, tapped, stroked and swiped, its arrangement of icons 'melts, so it seems, into reality itself, and is perceived as an actual property of surfaces, things and events' (2013: n.p.). Crucially, this melting of computation and reality is what design engages with, shaping users, constructing lifeworlds, terraforming experiences.

The notion of the interface as a threshold where two different forms of material intelligence, not necessarily human, meet can be further explored by drawing on Deleuze's reply to the question '*What is an event?*' 'Events are produced in a chaos', says Deleuze, 'in a chaotic multiplicity, but only under the condition that a *sort of screen* intervenes' (1993: 76; emphasis added). The process by which the pure multiplicity (*Many*) of chaos becomes a certain singularity (*One*) happens because 'a great screen' is placed between them. Deleuze likens this screen to a sort of universal sieve that extracts differentials out of chaos's own 'universal giddiness' (1993: 77) and orders them into discrete perceptions. This universal sieve can be thought of as 'a formless elastic membrane' or an 'electromagnetic field'. Chaos is inseparable from this screen, but, says Deleuze, it is this screen that makes 'something – something rather than nothing – emerge from it' (1993: 76). It is therefore an event-producing

I would like to take the interface as a historically located, culturally specific form of technology expressing Deleuze's event-producing screen.

As said, design has been shifting its operations towards this 'sort of screen', which has become the modulated and modulating object of design itself. This interface-based type of individuation cannot be reduced to a recognisable combination of form and matter. Instead, we have an individuation continually modulated in an incessant feedback loop of updating, access, data aggregation, reformatting of location and so on. Algorithm-driven objects collapse space and matter and make them indistinguishable, programmed remotely in a loop with instantaneous effects – effects both of reality and of subjectivity. Design is not only the process that constitutes the new technodigital object (the distributed, app-based *objectile*). It is also the process that programs the event. By designing the interface, design intervenes directly upon the screen that filters the giddiness of the chaos-cloud, and channels into programmed events. Through this process it also designs its users.

Taken as a sieve-membrane that filters the incoming chaos of data into an operational, tailor-made event, the interface can only be apprehended in conjunction with its own programmability. It is the design of the interface that makes possible the execution of a specific programme of action. The interface mediates between the physical and spatial sphere of action of the user, and the temporalities fabricated via cloud-based, platform-driven interventions. This mediation happens through a 'programmatically blending' of action and interaction. Design is the process of intervention on the threshold between chaos and event. The question is: how does design handle and manipulate the forms of intelligence circulating within this threshold? Let us investigate in more detail the characteristics of the technodigital object emerging at the encounter of human and non-human intelligences.

### *The open-ended technodigital object and its paradox*

Rethinking the status of the designed object on the basis of morphogenetic dynamics, Kwinter argues that objects must be defined by the system of forces traversing them and by the practices of which they partake. Echoing biologist D'Arcy Thompson's notion that the form of any given portion of matter, and its changes, are designed by force – specifically that the form of an object is a 'diagram of forces' (Thompson 1961: 11), Kwinter suggests that the unity and coherence of the object would vanish into a field of micro and macro relations; the 'micro-



which the object is part (2001: 14). A new paradigm for objecthood emerges: one that recognises the mutable, distributed, extensive relationality of objects. We no longer deal with a discrete, formal object, but with an *objectscape* made of distributed materials, bodies, techniques and practices, some human, and some not. Again, this relational perspective on objecthood draws on Spinoza's notion that bodies are made up of relations of movement and rest, speed and slowness between the parts that compose them (Deleuze 1988a). This focus on the kinetics and dynamics of objects, rather than on a bounded, discrete, essential object-'unit', has important implications. There is a shift from a distinct object seen in terms of its form, functions and fundamental objecthood, to bodies considered in terms of their capacities of affecting and being affected. Objects are no longer watertight and self-contained wholes but are open-ended. They are made by their conjunctions, alliances and disruptions with their surroundings and through the pliable architectures of intensities and forces that traverse them. Formed by the multiplicity of their connections and capabilities, objects become a mixture of agencies distributed across analogue and digital territories.

In this sense, technodigital objects are blurry entities, conflating hardware and software. Their operational modalities are both intensive and extensive, and always highly mobile, morphing, meshing. At the same time, however, technodigital objects afford the instant capture of locative identities, temporalised by data circulation and propagation. They produce subjectivities programmed to be as liquid as the processual flow of data/code they are traversed by, always on the verge of further, entirely programmed and captured, modulation. This tension between the openness of the technodigital object and its utter programmability is accurately reflected in its formal standardisation.

In fact, the more the processing capabilities, speed of connectivity and miniaturisation turn the technodigital object into an un-bounded entity that translates the universal into the particular, the more its design slavishly submits to the global design orthodoxy of the hand-friendly rectangular design. The standardised, ubiquitous and instantly recognisable hand-held device, possessing a predictable and programmable range of capabilities, has become the digital equivalent of a *black box*. Not only does this refer to the formal qualities of the device (a rectangular box). It also alludes at the concept of 'black box' in science studies. As Bruno Latour explains, black boxing refers to 'the way scientific and technical work is made invisible by its own success. When a machine runs efficiently, when a matter of fact is settled, one need focus only on its inputs

This could be easily taken as a paradox between material and immaterial. However, as Kwinter remarks, it would be absurd to oppose an allegedly material mechanical paradigm to an immaterial electronic one. Rather, the mechanical and the electronic are 'expressions of two continuous, interdependent historical-ontological modalities: those of Matter (substance) and Intelligence (order, shape)' (Kwinter 2007: 92). And yet, compared to mechanical processes, the electronic processes embodied in digital devices *appear* to possess a higher degree of material intelligence. Even more so, electronic processes 'appear to manifest the same magical qualities of *material intelligence* found in fundamental, free and unprocessed matter, a set of qualities that can summed up in the term, self-control' (2007: 93). There is, for Kwinter, an 'indeterminacy and magic of matter' (2007: 97) that opposes any electronic determinism and its entire disciplinary programme. To dismantle the illusion of autonomous control electronic mediation has accustomed us to, says Kwinter, we must follow the primitive and persistently morphogenetic path of matter.

Kwinter invites us to follow the "minor", *archaic* path through the microchip' (2007: 97) and to fold back the digital object into pure metallurgy, that is, into the impersonal path of nonorganic life. This is an invitation to push further Deleuze and Guattari's claim that 'what metal and metallurgy bring to light is a life proper to matter, a vital state of matter as such, a material vitalism that doubtless exists everywhere but is ordinarily hidden or covered, rendered unrecognizable, dissociated by the hylomorphic model' (1988: 411).<sup>13</sup> By following matter beyond the interface we reach the very core of the digital-computational machine we are part of: the silicon-made microchip. By following the trail of silicon we can grasp what matter is capable of, the intensities it produces, its unfoldings, its intelligence, and how it becomes individuated in the historically specific form of the technodigital object.<sup>14</sup>

### *Silicon, the revenge*

The microchip, an object made largely of silicon, is the essential component of our electronic world. Silicon is a crystal found mainly in common beach sand and dust. It is the most common element on earth after oxygen. The world of computation, the allegedly 'immaterial' world of data, our digitalised, manic connectivity: all hinge on crystals of sand and particles of dust.

In a 1980 interview with Catherine Clement, Deleuze discusses the 'life of modern machines'.<sup>15</sup> Here he succinctly considers the 'revenge of

You know, it's curious, today we are witnessing the revenge of silicon. Biologists have often asked themselves why life was 'channelled' through carbon rather than silicon. But the life of modern machines, a genuine non-organic life, totally distinct from the organic life of carbon, is channelled through silicon. This is the sense in which we speak of a silicon-assemblage. (Deleuze 2006: 178)

With the second part of the twentieth century dominated by silicon, the silicon-assemblage Deleuze speaks of has become a reality. Deleuze makes further reference to the 'potential of silicon' in the appendix to his book on Foucault (Deleuze 1988b). In the same text he mentions also the enigmatic *Superfold*, which emerges from the forces mobilised by silicon: 'It would be neither the fold nor the unfold that would constitute the active mechanism, but something like the Superfold, as borne out by the foldings proper to the chains of the genetic code, and *the potential of silicon in third-generation machines*' (1988b: 131; emphasis added). Here Deleuze points out the coming impact of 'third-generation machines, cybernetics and information technologies' on processes of formation of subjectivity. The era of silicon gives tangible form to the vision of a new individual (a superman) described as neither god nor man, but as the assemblage of the forces existing within the human, together with the forces from the outside. The form this individual may take is the form of these new relations of forces. Deleuze writes:

The forces within man enter into relation with forces from the outside, those of silicon which supersedes carbon, or genetic components which supersede the organism, or agrammaticalities which supersede the signifier. In each case we must study the operations of the superfold, of which the 'double helix' is the best-known example. What is the superman? It is the formal compound of the forces within man and these new forces. It is the form that results from a new relation between forces . . . It is man in charge of the very rocks, or inorganic matter (*the domain of silicon*). (Deleuze 1988b: 131; emphasis added)

In analysing the new forces at play in the coming domain of silicon, Deleuze states that these forces 'would no longer involve raising to infinity or finitude but an unlimited finity, thereby evoking every situation of force in which a finite number of components yields a practically unlimited diversity of combinations' (1988b: 131). The 'practically unlimited diversity of combinations' reminds us of the incessant torrent of data streaming at us from our always-on interfaces and beckoning our attention with its mesmeric power.

brings to mind the researchers and tycoons of Silicon Valley and their predecessors who since the 1950s have laboured to harness the forces of silicon. It also brings to mind the technodigital assemblages humans take part in almost permanently where, as stated in the opening of the chapter, carbon and silicon collide and recombine. Deleuze's superman bears no resemblance to the 1990s trope of the cyborg *à la* Donna Haraway (1991) however. Deleuze is unconcerned with some of the rhetoric of hybridisation of the opposite poles of a dichotomy (nature and technology, human and machine, and so on), with its embedded presupposition of dualistic essences as characterised by some of those cyber-discourses. Instead, he evokes a co-evolving and co-producing technodigital assemblage, more indebted to Simondon's notion of technology.

Simondon's genesis of technical objects tells us that objects are always the temporary concrete expression of a morphological and spontaneous evolution, which depends neither on natural processes nor on human design (Simondon 1980; Chabot 2013). Rather, technical objects gain 'an intermediate position between natural object and scientific representation' (Simondon 1980: 46). Moreover, far from evolving in isolation, technical objects are the result of a process where internal parts converge and adapt 'according to a principle of internal resonance' (Simondon 1980: 13). This process (*concretisation*) describes a convergence of functions within a structural unit by which the object acquires an internal coherence that propels it beyond the intention of its inventor. Even though they are designed and made by human beings, technical objects *have a life of their own* (Schmidgen 2012).

Simondon's theory is relevant to my argument as it explains how technogenesis, whether concerning common artefacts, intelligent machines or digital devices, is fully integrated into both culture and nature. Technical objects are not to be considered as an extension of a pre-existing body. Rather, technology is something fully inherent to human life (Braun and Whatmore 2010). Humans are always already among machines. Likewise, technical objects are already among, and cooperating with, humans: the natural and the artificial, the animate and the inanimate become closer to each other.<sup>16</sup> Which brings me to a discussion of silicon-based computation, its impending demise and its material transformation.

### *Silicon, between materiality and dematerialisation*

Deleuze's prophetic vision of a silicon domain also suggests that an

cannot exist without a full understanding of their materiality. However, as historians of technology Christopher Lécuyer and David Brock have pointed out in their ‘materials centered approach to the history of microelectronics’ (Lécuyer and Brock 2006: 302), genealogies of technology have largely ignored the materiality of microelectronics and semiconductors. Instead, the history of computation has focused more on the design of devices rather than on their materiality. To counteract this under-materialisation, Lécuyer and Brock remind us that microchips, with us since the early 1960s, have transformed entire industries, the built environment and ultimately how humans and things interact. Microchips are integrated circuits made of silicon: ‘postage-stamp-sized, thin slivers of silicon crystal that contain complex digital circuits’ (Lécuyer and Brock 2012: 563). The basic component of a microchip is the transistor: ‘a miniscule structure of chemically altered silicon and other materials that acts as an electrical switch. These tiny switches allow or prohibit the movement of electrical current through them, being either “on” or “off”.’ Transistors are the basis of all modern electronics; they produce ‘the inaudible hum of the digital world’ (2012: 563).

Silicon, the key component of the microchip, is a natural semiconductor. This means that it can be altered to conduct electric current or to block its passage. To make microchips, silicon is grown in vacuum chambers, and then stacked in ingots to be sliced into thin wafers. Today silicon microchips are everywhere. Our digital world depends on them and on their astonishing miniaturisation.

In the early 1970s advanced microchips contained several thousand transistors, each roughly the size of a cloud droplet, measured in millionths of a meter. By 2007 leading-edge microchips contained over a billion transistors. These transistors were now each approximately the size of a virus, measured in billionths of a meter. (Lécuyer and Brock 2012: 563)

For example, in 2007 Intel’s 45-nanometer (nm) technology produced transistors so small that 2 million of them would fit into the full stop at the end of this sentence.<sup>17</sup> In 2014 Intel released transistors made with 14-nm technology ( $1\text{nm} = 10^{-9}$ ).<sup>18</sup>

Such feats of miniaturisation are troubling. If on the one hand they seem to point to an eventual disappearance of matter – of which more below – on the other they reveal materiality’s persistence at the core of our digital world. Indeed, the more invisible matter becomes, the more firmly embedded it is within the computational paradigm: a paradigm that, as Kwinter observes, ‘has nothing to do with computers’ (2007: 53).

Remarking on the paradox of this tension, Gabrys observes that the microchip is essentially, but also ambiguously, ‘a miniature device that performs seemingly immaterial operations’, while requiring ‘a wealth of material inputs’ (2011: 24). She also usefully reminds us that information is an *entirely material* process of on-off electrical signalling. Consequently:

the transmission of information into bits, or binary units that correspond to electrical pulses, requires this composite of silicon, chemicals, metals, plastics, and energy. It would be impossible to separate the zeros and ones of information from the firing of these electrical pulses and the processed silicon through which they course. (Gabrys 2011: 24)

As Friedrich Kittler observed, there is no software, only hardware.

Gabrys makes another important point, drawing on philosophers Isabelle Stengers and Bernadette Bensaude-Vincent’s (1996) notion of *informed materials*: information-rich and context-related materials that cannot be perceived outside of their environment. If we consider electronics as made of informed material, argues Gabrys, as silicon enables the flow of electricity, matter seems to disappear (2011: 85). In other words, a silicon-based understanding of computation reveals the *interdependence* of material systems and informational systems. This interdependence concerns also the way the human body itself participates in these processes chemically, electrically, affectively. In the same way in which the *bit* as a switching model (on-off) is coupled to the actual operations of electrical currents, our living, electrical body is made of cells ferrying ions in and out of electrical charges. Through the interface apparatuses of eyes, ears, nose, tongue and skin, these cells are chemically converting the undercharged outside world into currents that create a fusillade of spikes through our brains (Simonite 2013; Tingley 2013).

### *Post-silicon, towards the brain: neuromorphic chips*

The convergence of digital and human points to a model of the technodigital assemblage that attends to the morphogenetic, growing capacities of the material in its bare components. There is a becoming-silicon in action through topological discontinuities that compute the assemblage human-technodigital by fragmenting identities and dissolving them into the endlessly replicable data swarms of manifold processes of subjectification. If the domain of silicon has to do also with infinite

disappearance of authenticity – what ensues is an anti-essentialism that sits comfortably with the idea that the regime of the Superfold points unequivocally *beyond* the domain of the silicon. As we have seen, for Deleuze the forces of silicon have superseded those of carbon. However, the relentless folding and unfolding of these forces (encapsulated by the Superfold) is now leading to a new phase in the lives of both machines and humans.

Some of the factors leading to this new phase have to do with the material capacities of silicon and the structural limits of the technology used to etch electronic circuits into silicon wafers (photolithography). The constant shrinking of silicon (silicon scaling) is pushing computers into the cul-de-sac predicted by Moore's Law, according to which the exponential increase in computation power is based on increasingly smaller and faster silicon transistors.<sup>19</sup> As said, Intel's latest chips are as small as 14nm. It is expected that by 2020 the size of these chips will be down to 5nm. Now, silicon ceases to exist as a crystalline solid once it has reached the threshold of 10nm, beyond which it becomes an amorphous material. The industry-led process of miniaturisation is shrinking silicon to its vanishing point (Winters 2003).<sup>20</sup> With silicon disappearing soon, what next?

Currently, the most promising area of research centres on neuromorphic chips (Hof 2014): microchips designed to emulate some aspects of brain behaviour. They attempt to model in silicon the way in which neurons (brain cells) behave, by changing how they connect to each other, and constantly learning and adapting through this process. Brains compute in parallel, with the neurons simultaneously connecting and influencing one another's electrical pulses via connections called synapses. As philosopher Catherine Malabou (2008) remarks, this process is called brain plasticity.<sup>21</sup> Each new input may cause a rearrangement of the synapses. The brain is, in other words, constantly in the process of being made, as a unique work. Neurons are more responsive to other neurons when their signalling activity is closely matched. This means that when groups of neurons work together in a constructive manner, their connections become stronger, while less useful connections may fall dormant (Simonite 2013). This is the process that underpins learning. In computing terms, it indicates a system that learns to reprogram itself.

Neuromorphic chips represent a new, alien form of intelligence (Simonite 2013). By learning through experience they constitute a leap from traditional chips. Devices powered by them will be able to learn

chips shorten the distance between artificial and natural computation by blurring the boundary between silicon and biological systems (Monroe 2014). Inspired by the way the brain works, they are self-learning and therefore able to reprogram themselves through nonlinear and chaotic processes. Because they encode and transmit data in a way that replicates the electrical spikes<sup>22</sup> generated in the brain as it responds to sensory information, neuromorphic chips do not mimic, but try to *simulate* brain behaviour.

Thus, they will be used to detect and predict patterns in complex data rather than simply to execute complex calculations. Because of their propensity to learn, neuromorphic chips could transform smartphones and other mobile devices into cognitive companions that pay attention to users' actions and surroundings and learn their habits over time, understanding intentions and anticipating needs (Simonite 2013). The idea here is *not* to replicate the brain in complete detail (an impossible task), but to detect patterns that can be applied to industry use. Neuromorphic chips will be used to increase digital devices' environmental intelligence by turning them into better 'companions' able to read changes in the ambient and to act accordingly. For example, image analysis and voice recognition, which at present are still processed via a cloud, will be learned by adaptation rather than by program (Monroe 2014).<sup>23</sup>

There are two other examples worth mentioning that indicate a convergence of silicon and carbon, organic and inorganic. The first concerns carbon nanotubes. From the point of view of the history of materials, carbon may logically constitute the next platform for microelectronics (Castro Neto 2010). Carbon nanotubes are hollow cylindrical structures made from a sheet of carbon atoms. They are only 1 nanometre wide – less than a million of an inch – and require very little energy to move. Nanotube technology may have the capacity to design a computer working at a molecular level, that is, a computer *not* based on an on-off structure, but on the *movement of molecules* (Winters 2003; Hsu 2013; Simonite 2014).<sup>24</sup>

The second example concerns what is known as 'dark silicon' (Taylor 2013). Dark silicon is the expression used to indicate largely underused swaths of silicon in microchips. This is silicon that is either idle for long periods of time, or not used all the time, or not at full frequency, due to the difference between a microchip's growth of computational capabilities and its capacity to utilise effectively this benefit. What this points to is a paradigm shift from a model based on speed to a model based on energy efficiency. This is affecting the design of silicon chips and the

energy-based paradigm, more akin to the nonlinear functioning of the brain. Indeed, the brain is already working in 'very dark operation' mode (Taylor 2013). While neurons fire at a maximum rate of approximately 1,000 switches per second, transistors toggle at 3 billion times per second. Thus, the 'most active neuron's activity is a millionth of that of a processing transistors in today's processors' (Taylor 2013: 17).

It is to the brain, its neurons and the pure movement of molecules, then, that digital science is looking, as it endeavours to rise to the challenge presented by the material morphogenesis signalled by the impending demise of silicon and by the emergence of new forms of intelligence that animate matter.

### Concluding Remarks

To locate better the argument about the intelligence of matter, what follows are some thoughts on Deleuze's conception of nonorganic life (Deleuze 2001). Whatever it is that animates matter, it is neither about innate properties, nor about intentionality. Rather, it is relational, because it has to do with traversing intensities and flows affecting, influencing and colliding with other intensities, thus engendering material consequences in the world. Nonorganic life is matter seen as immanently creative. There is creativity and effervescence in matter, not dependent on organic form, but occurring *prior* to any determination of form. Everything is alive. This does not mean that there is an external vital principle infused in inert matter. This material vitalism should not be taken as a mystical life force, but as the abstract power of *a* Life. The indefinite article '*a*' signifies precisely this: a life, before any specification (Deleuze 2001: 8), an impersonal power that precedes any organised and lived experience.<sup>25</sup> Deleuze and Guattari stress the importance of distinguishing between two interpretations of vitalism: 'that of an idea that acts, but is not – that acts therefore only from the point of view of an external cerebral knowledge (from Kant to Claude Bernard); or that of a force that is but does not act – that is therefore a pure internal Awareness' (Deleuze and Guattari 1994: 213). Instead, material vitalism should be treated as a force pulsating in everything, making matter vibrate. As philosopher John Rajchman writes, this impersonal and yet singular life that has little in common with what we call self, demands a 'wilder sort of empiricism – a transcendental empiricism' (2001: 9). This wild empiricism points to how to experience materiality prior any formal determination. We are back to intuition as the experimental,

apprehension of material variation, we grasp how things come to exist, how things are made and what makes them. We grasp how to relate to them.

This is how Deleuze and Guattari's radical materialism can articulate our relationship with the technodigital *objectscape*. It does so by providing an experimental, intuitive, material understanding of our interaction with, and experience of, digital objects, and by suggesting an ecology of the human and the non-human based on the crisscrossing and entanglement of silicon and carbon, and all their possible, wondrous becomings. Thus, the pertinence of Deleuze and Guattari's materialism to design should not be underestimated. Like design, it concerns the human and the non-human. As such, it prompts an argument in favour of an *anorganic* mode of expression and proliferation, where many diverse forces participate in the making of form. Design's task is to resist the hylomorphic convention of the form-matter coupling in favour of morphogenesis. As this chapter has argued throughout, morphogenesis offers ways of understanding the process by which objects come into being. This perspective also helps us to understand the complex demands posed by current technodigital objects. By posing their development as an evolution of different coexisting mutually affecting material intelligences, a morphogenetic perspective offers design new insights to rethink its response to the transformation of the technodigital object, and the issues this raises: the convergence of silicon and carbon; the increasingly independent life of objects and its impact on humans; how to move beyond the conventions dictated by the interface as the default form of interaction, and beyond the formalism of the black box.

The silicon-neural shift in the ways humans coalesce with the technodigital object demands a design paradigm that addresses our cohabitation with things and recognises the rapid transformations taking place within this cohabitation. Technodigital objects are never inanimate. The morphogenetic transformation of silicon heralds new forms of cognition – embodied, sensorial, contextual and distributed – that are quickly moving beyond ambient intelligence and leaning towards synaptic adaptation. The post-silicon, *neuromorphic* era, characterised by a breed of microchips that 'follow' neural activity, collapses the distinction between carbon and silicon, animate and inanimate matter, and works instead towards their convergence. New types of human-made things emerge, which are *simultaneously* animate and inanimate and are capable of expressing additive and adaptable intelligence, as well as learning through experience. What all this may imply for humans has to

This needs to inform the way design approaches technodigital objects. A morphogenetic model forces us to pay attention to the materiality of digital interaction, and the extent to which it is a key component of the technodigital assemblage we form with our devices. This is something that should concern design not only as the process of thing-making and meaning-making, but as the process of intervening upon that screen that separates and connects chaos and emergence. As I have argued elsewhere,<sup>26</sup> design must be alert to ideas circulating outside its most familiar domain. The approach suggested here assigns great relevance to an intuition-based following of matter, informed by Deleuze and Guattari's nomadic science. To think about design as a nomadic science – as opposed to the hylomorphic, iterative, retrofitting-prone, problem-solving, conventional view of design – means to regard it as a *minoritarian* line of creation, transformativity and becoming. To think about design as a nomadic science means to welcome non-human material agencies as key stakeholders in the process of design. These are the challenges to which design needs to rise.

If there is model for design research that Deleuze can inspire, it is most certainly within the boundless scope of a *nomadic, minoritarian* design, the rudimentary alliances of design with all its possible *elsewhens*.

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### Notes

1. My use of 'we', 'our' and 'us' throughout the chapter refers not simply to the community of those who habitually use a digital device: a community that is likely to overlap with the readership of this book. It also, broadly, intends to make a point about the global implications of such objects, which affect everyone, users or not.
2. See media theorist Friedrich Kittler's seminal essay 'There Is No Software' (1995). Software is by necessity a material thing: 'without the correspondent electrical charges in silicon circuitry no computer program would ever run' (Kittler 1995: 4). Similarly, digital theorist Florian Cramer (2004) argues for the elimination of the dichotomy between software and hardware, while insisting on the unequivocal materiality that software possesses in its stored, coded form, as well as a cultural practice.
3. For a critique of user-centred design see the Introduction in this volume.
4. Although design seen as a tool of complexification of the existent implies a critical perspective, this view does not necessarily align with what is known as 'critical design'. For a useful taxonomy of critical practices in design and a critique of critical design see Malpass 2013.
5. Félix Guattari's contribution to this radical materialism should be remembered. Guattari's critique of structural semiotics is important. This critique brings back material intensities to the system of signification signifier/signified and the system of representation content/form. This semiotics of intensities draws on the work of Hjelmslev, *the Danish Spinozist geologist* (Deleuze and Guattari 1988: 43) who breaks the duality between expression and content by introducing matter in their distinction and paving the way for a non-hierarchical, nonlinear and non-representational distribution of content and expression.
6. Deleuze and Guattari use the term *haecceity* to define 'a mode of individuation very different from that of a person, subject, thing, or substance' (1988: 287). 'A season, a winter, a summer, an hour, a date have a perfect individuality lacking nothing, even though this individuality is different from that of a thing or subject. They are haecceities in the sense that they consist entirely of relations of movement and rest between molecules or particles, capacities to affect and be affected' (1988: 288).
7. 'Reductionism is the method by which one reduces complex phenomena to simpler isolated systems that can be fully controlled and understood. Quantitative methods, on the other hand, are related to reductionism, but they are more fundamental, because they dictate how far reductionism must go ... this is, for example, the basis of the Cartesian grid system that underlies most modern models of form' (Kwinter 1992: 53).
8. 'Once time is introduced into this system, a form can gradually unfold on this surface as a *historically specific flow* of matter that actualizes (resolves, incarnates) the forces converging on the plane. These are the phenomenal forms that we conventionally associated with our living world. What we have generally failed to understand about them is that they exist, enfolded in a virtual space, but are actualized (unfolded) only *in time* as a suite of morphological events and differentiations ever-carving themselves into the epigenetic landscape' (Kwinter

9. In a recent interview Italian designer Gaetano Pesce said: 'I believe that my time – our time – is liquid. I use resin, elastomers, like silicon and rubber, and all liquids, which I mix and cure to make them soft and pliable or rigid, depending on what I want. The materials I pick are both *from* my time and representative of my time. I find the dripping and pulling emotional. I don't impose my will on the material. I let the material do a lot of what it wants. It's fantastic when you allow liquid resin to move. It does things I couldn't have commanded. The results can be even richer than you imagined' (Groen 2014: 180).
10. Intuition is 'the attempt to make explicit the fine threads within and between objects (including living beings) that always make them more than themselves, always propel them in a mode of becoming. What intuition gives back to the real is precisely that virtuality which complicates the actual' (Grosz 2011: 51).
11. On the sympathy of things see Spuybroek 2011: 159–67.
12. Compare to media theorist Lev Manovich (2014) for whom *software*, taken as the key new media of our time, having superseded all other media technologies used to produce, store, disseminate and access cultural artefacts, is *the* interface between our imagination and the world. In this sense software constitutes an entirely new affective and material dimension.
13. As archaeologist Chantal Conneller (2011) has written in reference to metallurgy, what must be noted is that the vital principle pertains to metallurgy as a *process*: the assemblage of things and energies partaking in the entire process of production.
14. Bratton makes a similar point in his discussion of software. Software is not only 'a device-language with which we act upon space, it is also itself a material architecture' (2002: 13) made of glowing screens, copper and fibre wires.
15. 'Eight Years Later: 1980 Interview', in Deleuze 2006: 175–80.
16. As philosopher Thomas LaMarre reminds us, however, the ontological distinction between technical individuals and natural individuals is never blurred. For Simondon, the tendency to collapse this distinction is 'not merely a metaphysical error, but a form of moral panic as well, which ultimately serves to depoliticize the technical existence of humans' (LaMarre 2013: 91).
17. See Intel's website: <http://www.intel.co.uk/content/www/uk/en/history/museum-story-of-intel-4004.html?wapkw> (accessed 7 January 2015).
18. See Intel's article on this from 11 August 2014: <http://www.intel.co.uk/content/www/uk/en/silicon-innovations/intel-14nm-technology.html?wapkw> (accessed 7 January 2015).
19. Gordon Moore was one of the co-founders of Intel Corp. He predicted in 1965 that the density of transistors in a circuit would double every two years to allow for the rapid progress in electronics.
20. *Transient* electronics exploit this property. They are thin and malleable silicon circuits (100nm or less) that emulate bodily activity and dissolve within the body when their task is completed – silicon electronics as no longer inanimate otherness, but an increasingly integrated part of that thing we call 'us' (Rogers Research Group 2014, <http://rogers.matse.illinois.edu>).
21. Malabou explains the difference between plasticity and flexibility. Flexibility, she says is the 'the ideological avatar of plasticity . . . To be flexible is to receive a form or impression, to be able to fold oneself, to take the fold, not to give it. To be docile, to not explode. Indeed, what flexibility lacks is the resource of giving form, the power to create, to invent or even to erase an impression, the power to style. Flexibility is plasticity minus its genius' (2008: 12).
22. It is not a coincidence that the first gaussian-morphic chip developed in 2012 at the

- 'Spikey' (Electronic Vision(s) Group 2014, <http://www.kip.uni-heidelberg.de/cms/groups/vision>).
23. 'Today's computers all use the so-called von Neumann architecture, which shuttles data back and forth between a central processor and memory chips in linear sequences of calculations. That method is great for crunching numbers and executing precisely written programs, but not for processing images or sound and making sense of it all. It's telling that in 2012, when Google demonstrated artificial intelligence software that learned to recognise cats in videos without being told what a cat was, it needed 16,000 processors to pull it off' (Hof 2014: 56).
  24. This harks back to the origins of computational machines such as Charles Babbage's design for the Difference Engine where computation was based on the repetitive motion of moving parts, for example, a stack of toothed wheels (Winters 2003; Marenko 2016a). Winters also recalls Eric Drexler's seminal work on rod logic which would substitute transistors' controlled electrical pulses with arrays of minuscule rods, each knobbed at precise points. The extension of a rod would prevent another rod from moving, in a similar way to how electric current fed into a transistor can block another current in a circuit. These 'shuttling' movements of open and closed 'gates' would process data. For Drexler, 'arrays of such gates could create an entire computer processor *smaller than a bacterium*' (Winters 2003: 51; emphasis added).
  25. One example that Deleuze uses is the 'obstinate, stubborn and indomitable will to live that differs from all organic life' of a new born baby 'who concentrates in its smallness the same energy that shatters paving stones' (Deleuze 1998: 133). This 'inorganic, germinal, and intensive' life is what Deleuze and Guattari also describe as the BwO traversed by powerful nonorganic vitality (Deleuze and Guattari 1988: 499).
  26. See the Introduction to this volume; also Marenko 2014; 2016b.

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## Re-designing the Objectile

*Derek Hales*

### Design and the Three Daughters of Chaos

What would thinking be if it did not constantly confront chaos? . . . chaos has three daughters . . . the Chaoids – art, science, and philosophy . . . [Each] cut through the chaos in different ways. The brain is the junction – not the unity – of the three planes. (Deleuze and Guattari 1994: 208)

It is something of a cliché in design studies circles to say that design is a practice in which the two 'chaoids' (Deleuze and Guattari 1994) of science and art converge. Such sentiments are found, for example, in the design methods research of John Chris Jones, one of the founding figures of the field of design studies,<sup>1</sup> albeit that in his *Design Methods* this entails the separating out of mathematics, perhaps as the third philosophical chaoid? 'The view put forward [by Jones] is that designing should not be confused with art, with science or with mathematics. It is a hybrid activity which depends upon a proper blending of all three' (Jones 1992: 11). These sentiments are echoed in a supposed hybridity which comes to be by design, an hybridity requiring some systematisation, suggests Nicholas Negroponte, for whom design needs to be codified as the 'methods, principles and rules for regulating the science and art of design' (Negroponte 1975: 31). Sentiments echoed too by Pelle Ehn who makes similar claims for digital design in a thought that might have been born out of the Bauhaus: 'Designing computer artefacts is both art and science' (Ehn 1989).<sup>2</sup> To follow this view, however, would be to hold with design as the simple synthesis of art and science and to consign designing to a search for unity within a *hylomorphic* scheme – that is to say, as the imposition of an external idea or form onto an inert matter. It is, rather, that matter is a flow, a matter-flow, and that design, thought and the technological become