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On scratching your own itch

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ABSTRACT

Following Massimo Banzi's comment that the Arduino development board might be seen as a means of 'scratching your own itch', this paper explores the concept of affect in relation to physical computing, and investigates the ways in which cybernetic and networked objects could be said to enact a series of process-philosophical and object-oriented tensions. In so doing it addresses the cultural saturation of Arduino and its employment in an array of institutional, artistic and activist contexts, and brings this to bear on the conflict between the process philosophy of Gilles Deleuze and the more directly object-oriented perspectives of Graham Harman, Ian Bogost and Bruno Latour. Framing the enquiry around the at once ethico-aesthetic and speculative realist questions of what it is to 'scratch' and what it is to 'itch', the paper examines micro- and macro-political agency in the context of physical computing—contrasting process philosophy's pronounced notion of affective, connective, creative differentiation with the black-boxed, withdrawn objects of object-oriented philosophy, and its quasi-causal mode of aesthetic interaction.

KEYWORDS

Arduino; process philosophy; object-oriented ontology; Gilles Deleuze; Graham Harman

1. Introduction

In a recent TED Talk, Banzi (2012), one of the originators of the Arduino development platform, made a number of observations that were concerned broadly with the character, reach and impact of the Arduino project. He described the open and distributed ethos of the Arduino initiative and positioned these qualities as characteristics of the open source and digital-making communities per se. He likewise drew attention to the ubiquity and cultural saturation of Arduino. That is to say, after explaining that Arduino was the control mechanism that sat at the heart of the first open source 3D printer, Banzi went on to highlight how the system was used by children, hacktivists and government institutions alike.

Banzi's examples illustrate the way in which Arduino is operational in both institutional and Do It Yourself (DIY) contexts—on the one hand it is employed as a data logger at the European Organization for Nuclear Research (CERN) and as the platform for peripheral development for Google's Android operating system, whilst on the other it reports more accurate statistics of radiation levels in post Fukushima Japan—countering the official government reports that seemed to downplay levels of contamination. Banzi drew attention to the use of Arduino in hacktivist and aid projects alike—citing the txtbomber as a system for the more efficient distribution of graffiti, as well as a DIY drone helicopter that could be utilised for the delivery of resources to remote and cut-off villages in Africa.

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Central to Banzi's broadly relational positioning of the project were the notions that, firstly, Arduino had arisen out of a pragmatic need (creating a rapid prototyping system for students to use at Ivrea), secondly, it had involved the input of an at once diverse, collaborative and contingent network of people (an international development team that was thrown together through their teaching at the same institution) and thirdly that the system as a whole constituted a 'mash up' of existing open source technologies such as GCC, AVR-DUDE, avr-libc and JAVA. He stressed that the level of engagement and participation that had built upon the platform had surpassed all expectations—and that Arduino had gone 'into every field imaginable' becoming an integral component of a vast and ever expanding array of technical systems.

Interestingly, Banzi's comments concerning the impact, creative potential and embedded nature of the project were coupled with observations addressing a more affective territory. That is to say, having explained to his audience that he felt 'overwhelmed' by the project's success, Banzi went to depict the creative use of Arduino as a means of 'scratching your own itch' which he closely equated with the idea of 'open-sourcing imagination'.

Although there is something faintly philosophically idealistic about Banzi's discussion of the issue, in the sense that he positioned the platform as a means of realising ones creative vision, his phrase 'scratching your own itch' also provides an avenue for considering the project in relation to contemporary aesthetics and to more materialistic, theories of affect.

2. Affect theories

Affect theorists are typically resistant to what they take to be ethereal 'mind-centric' approaches to the world (Massumi 2002; Bennett 2010; Gregg and Gregory 2010), frequently deriving inspiration from the 'double aspect' materialist philosophy of the seventeenth

century Dutch philosopher Baruch Spinoza (1955) that effectively collapses matter and sensation into the operation of a single substance. Accordingly, theorists of this kind typically distinguish two senses of the term 'affect'. The first, and more pedestrian of the two, is primarily psychological or phenomenological in character, being concerned solely with qualities of felt experience. This psychological notion of affect is manifest both in Banzi's feeling of being 'overwhelmed' by the success of the project, and also, if we take his metaphor literally, in the felt, qualitative sense of nagging irritation that we ordinarily describe as an itch. However, there is a second, more significant sense of the term, which stresses the ontological power of material things and their transformative effects upon the world. This has a greater materialist emphasis and thus a stronger connection with behaviour. Accordingly, with respect to this second sense of the term, there is less of a concern with how something qualitatively feels, and a stronger emphasis upon our pre-subjective and pre-personal entanglement with the material world. That is to say, from the perspective of affect theory there is a stronger concern with the processes and potentialities that in some sense constitute our changing subjective experience.

This latter more strongly physicalist notion of affect draws our attention to the behavioural imperative to scratch that is closely intertwined with the felt sense of itching, and to the behavioural imperative to 'make' that might accompany a speculative vision of possibility. Whilst seemingly opposed along phenomenal and materialist lines, the two senses of the term are not so easily extricated. That is to say, from a contemporary Spinozist position, there is a sense in which the imperative to scratch and the felt sense of itching are intimately connected. That is to say they are each an expression of the same energetic confluence—the different orders of connection, movement and rest which both carry and are carried through the abrasive felt sensation and the

movement of the body alike (Massumi 2002). Thus from the position of affect theory, a fingernail drawn across a localised area of the skin functions materially as probe, disruptive intervention and as an energetic re-channelling or re-distribution of kinetic force (DeLanda 2002).

Whilst affect theorists are generally critical of centred notions of psychological life that imply a Kantian or Cartesian subject or an overly cohesive self, they nevertheless affirm the notion that there is an intensive logic to experience. That is to say, they recognise that there is something materially significant in the rise and fall of sensation and emotion, or in the way in which emotional states envelop or occlude one another—positioning them as analogous to a more fundamental, but similarly intensive, set of material operations (Williams 2008).

3. Computational and performative conceptions of process

Banzi's comments were focused upon the pragmatic activities of the Maker Movement, but invite broader philosophical reflection upon concepts of process, object and relation, along with the relationship of these concepts to materiality, creativity and the production of the new. There is a clear sense in which the embrace of Arduino by children, hacktivists and government agencies alike when considered alongside the diversity of its operational contexts not only draws attention to the ubiquity and flexibility that is enabled by the Arduino's socio-technical context, but also highlights an important distinction that might be made between a reductive and a playful sense of material/machinic possibilities. That is to say, in one sense the machine logic of a computer perfectly exemplifies a kind of formalism. Standing as a physical embodiment or manifestation of a rationalist mindset it foregrounds concerns of clarity, efficiency and parsimony. This rather rationalist image of computation underpins its connection with management, classification and the reduction of the complex to the simple. Ultimately, it

was this rather disembodied conception of computation that dominated the early history of computing. The concept of the Universal Turing Machine was primarily concerned with simulation/replication of abstract functional systems. Whilst it is true that in essence it described a physical-mechanical computer with a memory tape that was infinite in length, it should not be forgotten that Turing's 'machine' was abstract, algorithmic and non-physical in character (Penrose 1989). Turing had attempted to create the minimal specification for a procedure that would be capable of capturing or simulating any other kind of formal mechanism—thus we might present him both as a conceptual thinker and as the superlative information 'de-signer'—in the sense that he stands as the author of a radically reductive and abstract concept of simulation. However, it seems slightly absurd—and somewhat ironic, that this collection of strictly formal requirements should give rise to a tool ideally suited to postmodern practice and production with its contrary aesthetics of complexity, plurality and difference. This seems perhaps less surprising when we consider the complexity of Turing himself. Dieter Daniels (2007) notes how Turing's description of the first phase of the Turing Test—an AI scenario in which an interlocutors must attempt to guess the gender identity of an anonymous pair of subjects—'reads like the perfect psychograph of Turing himself' and 'implicitly contains a thesis that forty years later Judith Butler (Fuss 1991) supported in a feminist context: gender identity is ... a discursive construct that first comes to light in performative acts'. Arguably, it is a more playful, performative and postmodern conception of computation that provides the context both for much computational art and for modes of digital activism. Here, the DIY ideals of the contemporary Maker Movement are supplemented with an agonistic politics, with the aim of developing socio-technical modes of political resistance. In contrast to Turing, the conception of function developed by Actor Network theorists

such as Bruno Latour (1993, 1996, 2005), John Law (Law and Hassard 1999) and Michel Callon (Callon and Latour 1981), though still systems oriented and still in many ways appealing to the managerial mindset, is bottom up as opposed to top-down in character. Latour's performative conception of function is both more materialistic and more playful than Turing's, ultimately allowing for—and even requiring—tensions, interference and slippage (Latour 1996). For Latour, there is recognition that systems are founded upon performative regularity, but there is also a recognition that all such performances are contingent and provisional in character—embodying internal tensions and contradictions, and likewise being susceptible to external influence that results in their transformation.

4. A process-philosophical lineage

There are tensions between the concepts of object and performative process that can be located in Actor Network Theory, and this serves to foreground its process-philosophical lineage. Process philosophy has been present as a minor current in Western philosophy since as early as 540 BC (Rescher 1996). Process philosophies tend to emphasise both the ontological priority of change and the relational constitution of entities. From the perspective of process philosophy, the world of stable and enduring things arises out of a differential play of interacting forces that admit of multiple and contingent patterns of relation (Rescher 1996, 10). Given its emphasis upon the movement, transformation and development of phenomena, as well as its emphasis upon external or extrinsic relations with respect to the constitution of things, the process perspective is less interested in any stable, essentialist or object-centric definitions of the substance of entities, but instead focuses upon performative descriptions of their role and constitution (Rescher 2000, 15). Thus there is a functionalist orientation to process-relational thinking, but it is a functionalism that is tempered with a creative

and vitalist bent. Accordingly, the process perspective is as much interested in the transformation of practices as it is in their functional description, and interestingly for our purposes here, such transformation is itself typically presented as the result of the connection of things through some kind of material encounter. Process ontology tends to be philosophically monistic in character, positioning all phenomena as, at root, a manifestation of a more fundamental category of material-process. In this sense, it has a reductive slant. However, with the adoption of the seemingly neutral category of 'process' as its foundation, there is an important sense in which it prioritises neither the conceptual nor the experiential in its account of phenomena. That is to say, implicated in process-relational philosophy's ontological monism is a phenomenal pluralism that is neither straightforwardly empiricist nor straightforwardly idealist in character (Rescher 2000, 9). Thus the process perspective brings with it a multi-modal, connective emphasis that confers a distinctive neutrality upon its analysis, and this brings it to bear upon a wide range of phenomena. Thus, from the perspective of process philosophy there are levels and modalities of emergent order, but there is also a sense in which everything is capable of melting or morphing into everything else (Rescher 1996, 15). As a consequence, process philosophy has the power to collapse dualistic vocabularies and deal positively with systemic tensions—ultimately suggesting a picture of the world that emphasises complexity, emergence and the aspectual qualities of things. With this picture of connective transformation in mind, Rescher has noted that one of the great promises of process-relational thinking is its methodological power to formulate comparisons (Rescher 1996, 4).

5. Arduino and process-philosophical analysis

Consideration of the character of the Arduino board lends itself to such a process-relational

analysis. Thus in a recent paper presented at the new materialist *Non Human Turn* conference, Lessard (2012) discussed the way in which we might consider the Arduino under a variety of interfacial aspects. Lessard drew attention to the physical, software and electrical interfaces that are involved in the production of an Arduino project. This flexibility of aspect illustrates the way in which it is possible to take radically different ontological stances within the context of digital design. Thus, for contemporary ‘cultural’ theorists such as Manovich (2013), who in some sense inherits a set of structuralist, linguistic concerns, it is only software that matters—for Manovich, the contemporary ‘medium’ in McLuhan’s socially transformative sense of the term is ultimately software. Accordingly, artists such as Manovich (or ‘net artists, as they were once known’) focus predominately upon the way in which software frames experience, and upon visualisation of the Internet’s rhizomatic relational qualities. Manovich frequently addresses the sublime scale of networked, digital connection, and this perhaps connects with Banzi’s sense of feeling ‘overwhelmed’ by the success of the Arduino project. In the context of physical computing, however, where notions of hardware and the physicality of things are prominent, both the materiality and embedded, environmental relationality of things come to the fore. For technological determinists such as Kittler (Kittler and Johnston 1997), there is only hardware—software is at root a particular material configuration temporarily burned into the architecture of microprocessor. In recent times, through the notion of ‘the internet of things’—a term first coined by Kevin Ashton in 1999 to address the commercial use of radio frequency identification technologies that has latterly been subject to critical interrogation by Sterling (2014)—a third aspect or frame of reference has emerged that serves to collapse the distinction between (linguistic) software and (material) hardware, emphasising instead a generalised connective/communicative ambience. At root, the interfacial aspects of software,

hardware and electrical interface are functionally united through a common concern with choreographing relations and events. That is to say, whichever of Lessard’s interfacial aspects is under discussion, the Arduino operates as a means of selectively channelling, routing and producing networks of relations at some level of description. Thus, from this perspective, there is a sense in which the Arduino and other physical computing platforms might be said to both participate in and orchestrate events. Ultimately it is consideration of the conflicted agential status of objects and processes that draws attention to one of the fault-lines of process-philosophical thought. To elaborate a little, there is a sense in which, at a certain macro-level of description, we can simplify the complexity, porosity and seemingly ambient character of material-relationality by making a distinction between ‘internal’ and ‘external’ relations—that is to say, in the context of Arduino, we might make a distinction between activities taking place ‘within’ the microcontroller itself, and the way in which the microcontroller couples externally with the physical world through quantised environmental information. However, a more systemic, ecological consideration or the problem foregrounds the way in which, through any such coupling, an entity becomes actively embedded within broader environmental circumstance and is thus ‘taken up’ by a higher description, or by an emergent body of functionality. This is likewise helpful in understanding the ubiquity of Arduino and its versatility of application—the way in which, to quote Banzi, it has made its way ‘into every field imaginable’.

These early considerations of software, hardware and environmental functionality are useful in so far as they illustrate the versatility of the process-philosophical outlook and demonstrate its capabilities with respect to performing aspectual shifts in terms of the scale and modality of analysis. We will shortly explore this in more detail when we examine Harman’s (Bryant et al. 2011) object-oriented critique of

the process perspective. Before doing so, however, it makes sense to explore the way in which process-philosophical thought likewise enables a seamless slide between notions of organic and inorganic agency that are fundamental to most contemporary materialist forms of analysis.

6. Machinic and organic agency

Back in 2002, whilst exhibiting collaboratively at the the Inter-Society for the Electronic Arts (ISEA) in Nagoya Japan (Pettican and Roberts 2002), I witnessed an early incarnation of Natalie Jeremijenko's Feral Robotic Dog project (Jeremijenko 2002–2006). At this stage of development the artist exhibited a pack of modified 'toy' walking dogs. At this time, the sensorimotor mechanism of the dogs was fairly simple—and as a consequence the interaction with the audience was still crude—the presence of passers-by would trigger the dogs, setting them off as a pack. The effect was at once alarming and slapstick in character. The dogs would surge forward in an uncoordinated fashion—yapping and barking, whilst some of them would crash into one another, or fall onto their sides. Once fallen they would twitch and spin helplessly on the floor as the motors in their legs continued to cycle. Despite its simplicity, Jeremijenko's project, through its crude sensitivity to bystanders, nevertheless established a kind of embedded ecological interaction—the movement of the 'pack' startled the audience whilst eliciting laughter, delight and influencing the flow of bodies through the space. At this time, Jeremijenko was already experimenting with practices of socially and environmentally engaged critical making—her Feral Robotic Dogs project has from its outset involved students and members of the public in the construction and assembly of the dogs. More, sophisticated versions of the dogs were equipped with toxicity sensors and gained the ability to seek out environmental pollution (DiSalvo 2012). Consideration of the

sensorimotor coordination of automata alongside simple biological organisms reveals an interesting parity that illustrates how easily we can transition between machinic and biological levels of description. In consideration of this transition we might draw upon the way in which in *A Thousand Plateaus*, Deleuze and Guattari (2008) famously utilised the biosemiotic thought of von Uexküll (1964) and his notion of Umwelt, or species-specific lifeworld. Deleuze-Guattari's practical discussion of the Tick as minimal organism with an extremely limited environmental sensitivity is useful in that it illustrates the importance of the concepts of sensation, abstraction and connectivity in Deleuzian philosophy, illustrating its processual character, as well as the way in which these concepts can serve as a gateway to a fully ontological conception of relation. Thus we are presented with a picture of a creature, which has a limited experiential and behavioural repertoire:

The Tick, attracted by the light, hoists itself up to the tip of a branch; it is sensitive to the smell of mammals, and lets itself fall when one passes beneath the branch; it digs into its skin, at the least hairy place it can find. Just three affects; the rest of the time the tick sleeps, sometimes for years on end, indifferent to all that goes on in its immense forest. (Deleuze and Guattari 2008)

We can glean from the passage above that the Tick is sensitive to light, the odour of mammals, the sensation of hair and the temperature of blood. These sensitivities are relational in the semiotic sense, and they trigger respective behaviours (climbing, falling, sucking blood). This example further brings out the ambiguity in Deleuze usage of the term affect—in one sense it refers to an experiential order (the sensation of light, the smell of a mammal, the texture of hair and the temperature of blood), but in another it refers to the capabilities of a body—or to what this particular body—in this particular, contingent set of environmental circumstances—can do (Spinoza 1955; Deleuze 1988).

It is perhaps worth noting at this point that despite the technological connotations of the term of ‘cybernetics’, the concept is concerned only in a secondary sense with the idea of robotics. Primarily, it addresses navigation and the material negotiation of an agent with respect to its environment or milieu—with ‘cyber’ translating as ‘steersman’ (Ryan, Emerson, and Robertson 2014). Thus the concern of both Actor Network Theory and theories of affect with material-semiotic relations can also be seen to resonate with the cybernetic investigation of the world—or with what we might describe, following Deleuze, as an exploration of the material world or ‘the intensities of a situation’—be it conducted by a human being, von Uexküll’s Tick, or the inputs and outputs of a microcontroller. The software engineer and speculative realist philosopher Bogost (2012) has recently explored what he takes to be a more democratic conception of perception—developing an expanded ontology that takes into account, among other things, the ‘alien’ phenomenology of sensors, cameras, computers and peripherals.

7. Machinic and material environments

It should be clear from what has been said thus far that this at once material-semiotic and embodied sense of environmental navigation need not be limited to consideration of hardware, or the ‘natural’ material environment. That is to say, the concern here is with the concept of exploration in the abstract, and accordingly such ideas can likewise be connected with the navigation of a disembodied, seemingly ethereal environment such as the World Wide Web. In the early, low-bandwidth days of the Internet, the idea of ‘surfing’ the net at times seemed absurd. This was primarily due to a certain incongruity of speeds—waiting for a page of text to appear or for an image to download was not an experience charged with adrenaline. However, the significance of the ‘surfing’ metaphor lies not in its

connection with velocities, but in the way in which it addresses the navigation of a semantic and semiotically intensive network—and this need has little connection with the concept of speed. The salient point with respect to the application of this metaphor is that the individual browsing the web navigates by variously seeking out, or being seduced by the assorted hyperlinks, hotspots and lines of connection within the page—these are the thresholds or zones of intensity, which can lead to the opening of new set of possibilities and to a transformation of a user’s experience. With this intensive picture of environmental navigation in mind, it seems no coincidence that Wiener’s (1948) seminal work on cybernetics addresses both animals and machines. Indeed, an interest in cybernetics and ecology often coexist, or are run together in the writings of luminaries such as Wiener and Gregory Bateson (1972).

DiSalvo (2012) has recently discussed Jeremijenko’s later neo-situationist interventions into public spaces, placing them in the context of political agonism and social dissent. Jeremijenko orchestrates events whereby she releases her robotic dogs in public parks as a means of ‘sniffing out’ pollutants, whilst simultaneously creating a novel form of public spectacle. These two phases or iterations of Jeremijenko’s project are interesting in so far as they illustrate the way in which the microcontroller embedded within the dogs became more refined in its relational/semiotic sensitivity, and how this expanded the creatures’ abilities. The dogs, now able to respond to stimulus from a toxicity sensor, could channel this broader spectrum of environmental sensitivity—resulting in more nuanced control of the servo-motors controlling their legs. Whilst in one sense the dogs might still be said to choreograph and channel a limited set of environmental relations, it is nevertheless the case that if we consider the dogs in aesthetic and affective terms—as a form of spectacle, as it were—we can see how they are also implicated in a broader and less predictable form of

relational play. That is to say, when considered in affective terms, Jeremijenko's dogs create a public spectacle that incites delight in an at once playful and sinister fashion, mobilising sub-representational viral imperatives, that serve ultimately to generate media exposure and to propagate environmentalist ideas and ideals.

8. Institutional and amateur making

DiSalvo grounds his discussion of Jeremijenko's work in a consideration of tactical, critical design practices that unsettle forms of political hegemony through the staging of events. DiSalvo likewise emphasises the way in which hacktivist projects like Jeremijenko's not only engage in a micro-politics of disruption—employing 'unskilled' labour in the context of performance software workshops—but also question, contest and reframe notions of what constitutes expertise.

It is perhaps worth noting here that the history of electronics and invention is particularly illustrative of the way in which formalised academic knowledge is parasitic upon the passion of the amateur (a term which, tellingly, translates as both 'non-professional' and 'lover') as they explore undisclosed frontiers through an informal and non-institutional experimental practice. Much of the innovation in the history of electronic invention took place outside of any formalised institutional activity, in spaces of informal creation such as the home laboratory and the inventor's workshop or shed. It is this kind of informal experimentation that is embraced and celebrated by both the Arduino project and by the Maker Community as a whole, most notably in their celebration of the practice of 'tinkering'. Indeed, from a materialistic perspective, the activity of the amateur, or the unsalaried 'lover' of a particular practice, can be seen as a pre-requisite for institutional formation. Accordingly, in his *1000 Years of Non-Linear History* DeLanda (1997), building on the on the insights of Peter F Drucker, tells us:

Few of the major figures in 19th century technology received much formal education. The typical inventor was a mechanic who began his apprenticeship at age fourteen or earlier. The few who had gone to college [Eli Whitney, Samuel Morse] had not, as a rule, been trained in technology or science, but were liberal arts students. ... Technological invention and the development of industries based on new knowledge were in the hands of craftsmen and artisans with little scientific education but a great deal of mechanical genius.

DeLanda goes on to suggest that a condition for the implementation of the industrial laboratory of the twentieth century was the material context of the 'self-taught inventor' of the nineteenth century but following the institution of the industrial laboratory, there came a 'reversal in the balance of power between formal and informal knowledge'. A similar pragmatic and materialist approach to institutional history can be located in David Bodanis' *Electric Universe* (2005).

DeLanda's point is that the emergence of universities and formalised knowledge economies arises out of contingent material and historical processes—indeed, he goes on to extend this, in the spirit of process philosophy, to 'all structures that surround us and form our reality (mountains, animals and plants, human languages, social institutions)'. One consequence of DeLanda's broadly process-oriented Deleuzian materialism is a foregrounding of the importance of extrinsic and contingent nature of relation. That is to say, for DeLanda it is out of material forms of practice that both institutions and institutional norms ultimately arise, and there is nothing natural, eternal or necessary about the institutional arrangements of the knowledge economy. In short, he emphasises the way in which practice precedes theory in the formation of socio-cultural circumstance. Accordingly, such constructivist practices are fixated upon concepts of change and transformation, and as a consequence, contemporary materialisms often have a revolutionary bent.

In the context of electronic digital media, there is a concern with distributed, networked forms of social organisation/interaction, as well as processual concerns with input, output and the encapsulation of function, and this can be seen to be manifested both at the levels of hardware and software. With this in mind, it is easy to see how Bruno Latour's Actor Network theory, or DeLanda's own Assemblage Theory (2002, 2006), has had such purchase, emphasising as they do the neutrality or flattening of actors (human/non-human) into functional networks, along with the at once material, affective and semiotic systemic connections that serve ultimately to constitute them. Thus Latour's position is useful when attempting to theorise the connectivity of digital artefacts or when attempting to trace patterns of human computer interaction in a democratic and non-anthropocentric fashion. However, it is important to remember that Latour's ontology is intended to account for *all* phenomena as products of heterogeneous, socio-technical, networks and that it is intended to be applied outside of a purely digital, electronic or computational realm.

Perhaps unsurprisingly, Latourian ideas have a particular appeal to those working in the contexts of computational forms of art and design. This is to be expected, given that Latour's ideas arose out of science and technology studies—a field of enquiry concerned not only with the socio-cultural analysis of science and its technical products, but also with technological modes of representation and the role of computation metaphors within contemporary culture. With this in mind, it is worth considering how new materialist ideas impact upon naturalistic and computational conceptions of process. Bogost (2010), the speculative realist most prominently concerned with technological analysis, has made an interesting distinction between 'process' and 'procedure' that can help us to understand one of the core tensions between process and object-oriented philosophies. Bogost notes how a 'procedure' (in computational terms)

can be considered as a form of representation that addresses the operation of things—their 'logic of behaviour', or 'how they proceed'. For Bogost, such procedural forms of explanation provide a valuable perspective on the nature/character of any given entity. He goes on to explain how the concept of 'process'—at least as it occurs in the context of process philosophy—should be distinguished from such functional and representational concerns, being primarily concerned with an unanalysed 'flow of events' or with what he goes on to term the 'hydraulic rush' or the perpetual 'becoming' of reality. As such, for Bogost, process philosophy's metaphysics of novelty or creation is unable to provide anything approaching a genuine form of explanation. Bogost goes on to develop an account of the importance of 'white boxing' or 'glass boxing' of actual entities—which he positions as a practical mode of analysis that attempts to infer the procedures/assumptions that coordinate the operational dynamics of any given entity. Bogost notes how glass boxing is at once a metaphorical and representational activity, involving both inference and analysis. This account of procedural representation feeds into an at once technologically deterministic and activist line of thought that stresses value of procedural thinking in unpicking the rhetorical operation of systems (the way in which software could be said to programme us). This mode of thinking will be familiar to anyone who has attempted to contemplate or penetrate the workings of another system—be it in order to implement the simplest hack/augmentation of a child's toy, an attempt to decode the communications protocols of a system/peripheral that produces serial output, or simply, to use Bogost's own example, the pondering of the political assumptions that might be encoded in the latest world building strategy game (Bogost 2007).

Despite a healthy interest in rhetoric (a mode of persuasion more at home with materialist talk of 'degrees' and 'intensities' than with logico-propositional modes of discussion), Bogost's examples of procedures are or the

most part clean, rationalist and overtly machinic. As a consequence, they betray his more overt concern with software and seem slightly removed from the more gritty organic materialism of the seminal speculative realist, Graham Harman, who is as likely to discuss the visceral life of oil slicks and slag heaps than anything explicitly technological. Nevertheless, it is Harman who serves as the primary inspiration for Bogost's thinking. Bogost's notion that white boxing is a metaphorical means of representationally modelling other entities does, however, draw attention to what object-oriented ontologists see as the inherent internal privacy of entities. Thus Bogost is keen to emphasise that within any given entity, 'swirls of murky logics turn'—and that it is this 'hidden logic', when combined with the propensity of entities to combine and form other entities that is ultimately responsible for the emergency of novelty in the world. For Bogost, the internal logics that trigger the transformation of the world may be dark or cloudy, but it is important to remember that they are logics nevertheless.

A second, more visceral and more directly material approach to the representation of the internal privacy of things can be found in the work of the artist Martin Howse—which serves to connect the murky rationalism of Bogost with the dark materiality of Harman. Howse's 'detektors' (2007—ongoing) are tunable devices for 'full spectrum exploration of the electromagnetic domain', which assail their user with a variety of hums, clicks, howls and squeals, alongside quasi-rhythmic sonic punctuation and bursts of white noise. This form of sonification serves to reanimate our perception of the at once internal, and alien life of 'solid state' technologies in a way that poignantly supplements Bogost's more distant, functional and representational form of modelling. Accordingly, we might borrow a distinction between politics and the political that has recently been employed by both DiSalvo (2012) and Fry (2006) in works addressing design and politics, to suggest that for the most part Bogost analyses

the external politics of things (their routine 'unit operations' and protocols, whilst Howse's more material interventions, attempt to more directly articulate the opaque political subjectivity of things through a process of sonic mediation. Arguably, however, it is only by combining the perspectives of Bogost and Howse that we can come close to the oddly visceral-material-rationality that is suggested by Harman's object-oriented ontology.

Carolyn Christov-Bakargiev's dOCUMENTA, 2013, provides an interesting vehicle for considering the application of new materialist thought in non-computational contexts as it was strongly influenced by Latourian ideas as well as emerging forms of new materialist and speculative realist thought—but consisted for the most part of non-digital, material artefacts, which were nevertheless expressive of a set of contemporary materialistic concerns. Thus Bakargiev's selection included Huyghe's (2011–2012) sculpture of a reclining female nude on a cement block, which followed classical sculptural conventions with the exception that the head of the figure had been replaced by a hive of swarming bees, and Geoffrey Farmer's *Leaves of Grass* (2013)—an enormous sculptural collage of cultural detritus that was entirely constructed out of images cut or torn from copies of life magazine from 1935 to 1985—emphasising the viral, vital and rhizomatic quality of the growth and transformation of culture over a period of 50 years. Bakargiev's exhibition also included Ryan Gander's *I Need Some Meaning I Can Memorise (The Invisible Pull)* (2013) which consisted of a breeze flowing through the otherwise empty ground floor of the Fridericianum—attuning us to the movement, reality and tangible operation of breeze—a somewhat neglected range of the agency spectrum that all too often goes unnoticed in our day-to-day environmental dealings.

It should be clear from what has been said thus far that the writings of speculative realists such as Harman and Bogost, along with works of new materialists such as Bennett and Bakargiev, combine a recognition of the obstinate

intractability of ontological essence with a material, vitalistic and ecological emphasis that nevertheless presents a picture of environmental embeddedness, material constitution and agglomerated, aggregative agency, and it should be clear that there is a strong degree of compatibility between these positions and the more machinic and somewhat angular analysis of Latour. It should likewise be apparent that much new materialist thought presents us with a picture of impersonal, nested interaction that admits of numerous levels of description. The process philosopher Nicholas Rescher captures this well when he suggests that reality itself might best be considered:

One vast all encompassing megaprocess consisting of virtually endless concentration of subordinate sub-processes—a Chinese nesting of box within box as it were. (Rescher 1996, 94)

9. The angular and intensive analysis of identity

Despite many points of overlap, the various strains of new materialistic thought that have been presented thus far suggest rival pictures of angularity and intensity. Thus for some new materialists the image of an atomistic node-line connectivity dominates, whilst for others there is a more diffuse, field-based, kinetic approach to phenomena. This should not be surprising, when we consider how the vitalistic functionalism of new materialist thought serves to level notions of human and non-human and to collapse ‘natural’ and ‘technical’ realms.

There is a dispute running through much contemporary materialist thinking that arises out of a broadly post-structuralist concern with anti-essentialism that is premised upon notions of performativity and the operation of difference, and which serves ultimately to complicate discussions of identity. The problem arises, because the same patterns of argument that are employed as a means of establishing the centrality of performance, functional

aggregation and levels of description to the attribution of agency in Actor Network Theory, for instance, seem—when followed through to their conclusion—to result in the de-materialisation, and disempowerment of the political subject (Irigaray and Pluha 2008).

To elaborate a little, we have already seen how process-philosophical thought attempts to reduce stable, ordered and bounded entities to prior forms of movement and connection. As a consequence, issues of scale, porosity and their distribution across a variety of scales are effectively intertwined and as such must be discussed in tandem. There is, according to the process perspective, a macro-level of analysis, at which I might describe myself variously as an individual human being, or as a socio-political actor. Looking upwards (and outwards) from this vantage point, however, I might likewise cite my contribution to, or absorption in, the agency of collectives, or of other social institutions of which I am a part. Looking further still I might draw attention to my relational connection to society or the wider natural world. Process philosophy operates on a cosmological scale and as a consequence I may continue working outwards ad infinitum, considering my place in the cosmos as a whole. Conversely, looking down (and in), there is another sense in which I must acknowledge that my body is dependent upon a multitude of other (non-human) actants. Even at this early stage of analysis, I seem to melt into different magnitudes of agency and order. Indeed, there is an important sense in which Charles and Ray Eams animated film *Powers of Ten* (1968–1977) and the book that inspired it—Kees Boeke’s *Cosmic View: The Universe in 40 Jumps* (1957) could be said to illustrate one of the fundamental problems of design. That is to say, the Eams’ film provokes a bewildering and sublime sense of systemic interrelation, whilst simultaneously provoking a vertiginous desire for boundaries and order as the camera, indifferent to the border-threshold of human flesh, appears to seamlessly zoom between macro- and micro-cosmological extremes.

10. The object-centric critique of process philosophy

Both post-modernism and post-structuralism in their resistance to any timeless or natural conceptions of order develop strategies of resistance that recast seemingly ‘natural’ or ‘eternal’ forms of social organisation, presenting them as artificially constructed and as highly contingent in character. Post-structuralism arose out of revolutionary politics, but it has not been without its critics on the left (Irigaray 1985; Haraway 2008), who have drawn attention to the way in which its emphasis upon the performative and contingent ultimately serves to decentre and diffuse political agency. That is to say, for process philosophy’s detractors, the dematerialisation of the object of resistance (the positioning of institutions as contingent, non-essential constructions in an attempt to facilitate their transformation) likewise entails the dematerialisation of the object that resists (e.g. the dematerialisation or decentring of the political actor or revolutionary). Thus, the famous dispute between the feminist philosopher Luce Irigaray and the process-materialist Gilles Deleuze concerned the status of political agency (Irigaray was primarily concerned with female political agency, but her argument can be extended to molar categories of object-oriented agency per se). Irigaray objected to the way in which Deleuze’s philosophy positioned the ‘actual’ macro-phenomenal world of people and things as a kind of fiction, or as a second-order reality that arose out of a more fundamental material play of forces, that Deleuze described as the Virtual. For Irigaray, Deleuze’s philosophy, in what she took to be its abandonment of any notion of ‘molar’ agency, effectively neutered its own political power. In a similar fashion, the speculative realist Harman (Bryant et al. 2011) has more recently suggested that Deleuze fails to appreciate both the integrity of individual things along with their agential power to transform the world. For Harman there is an important sense in which Deleuze’s philosophy ‘overmines

entities’ in its reduction of things to their constitutive relations. Irigaray’s ‘agent-centric’ critique of Irigaray was (tangentially) extended in Haraway’s (2008) critique of Deleuze that presented Deleuzian philosophy as ‘other worldly’, and thus not truly grounded/ecological, and as we shall shortly see how there is a comparable tendency in speculative realist criticism to position Deleuze as a kind of contemporary mystic, propagating an esoteric, and ultimately impoverished philosophy that is disconnected from the actual world.

Deleuze and Guattari’s (2008) implicit response to Irigaray is, however, interesting—drawing attention to the excessive abstraction that conditions her employment of binary, conceptual, categories (e.g. male/female) and suggesting that a properly materialistic politics should be less abstract and more complex—allowing for not just for two, but for what Elizabeth Grosz (1993) would go on to term a ‘thousand tiny sexes’.

Such ‘actualist’ criticism tends to either ignore or downplay Deleuze’s own political activism, and his more practical work with Guattari. It is however useful in so far as it draws attention to the activity, range, hybridity and vitality of ‘actual’ networks. By way of illustration, and bringing the discussion back to the context of Arduino, it is important to remember that when considering the Arduino project from a network perspective, we must think electrically, functionally, socially, materially and semiotically. That is to say, by dwelling on the electrical interface alone we miss the way in which Arduino was taken out of the world of computing and amateur electronics and inserted into networks of design culture. Thus, the initial Arduino boards were soldered by hand in a succession of maker workshops—and similarly, it was a series of forum-based competitions that gave rise to the initial Arduino logo and brand. At the time of its inception, Arduino stood as a rival to much more expensive peripheral interface controller-based development systems such as the i-cube. Arduino’s success in the milieu of physical computing was a result of a

number of factors: cost effectiveness; the integration of the diverse array of development systems that were needed to programme solid-state devices into one self-contained solution; and an open architecture which in turn gave birth to a wealth of peripherals, as well as to a plethora of ‘clone’ and mutant devices (versions of the board with extended functionality, which were typically constructed by third-party makers). However, in discussion of the circulation and mutation of the Arduino, it is important to also address the circulation of images—the production and dissemination of distinctive promotional devices such as logo/packaging/stickers (respectively ways of territorialising and distributing identity) that in part arose out of reciprocal relationships developed with design communities and networks. It was only in a late stage of development that Giorgio Olivero of the design firm ToDo (himself an ex-tutor of Banzi) was tasked with finally planting the Arduino’s flag—exchanging its plain, brown-box packaging for Pantone 313.

11. Harman’s object-oriented ontology

The spat between Irigaray and Deleuze points to a core tension in contemporary realist philosophies between philosophers that emphasise the material-processual constitution of entities—such as the new materialist Bennett (2010) and the speculative realist Grant (2006)—and those that assert the primacy of objects. With respect to the latter thesis, there is a weak sense in which we might cite the black-boxed, angularity of Latour, but a much stronger object-centric thesis has been proposed by Harman, in his object-oriented philosophy, and it is to this which we will now turn.

Rescher (1996, 27) has described how the fluidity of process philosophy enables it to partake of many forms of philosophical analysis. Thus he distinguishes between ontological and epistemological forms of processual thought. According to Rescher, the former has a

metaphysical bent, whilst the latter stays close to empirical states of affairs. This provides an interesting bridge between the broadly empirical approach of Latour (describing tangible networks of agency that are visible in the world) and the speculative, object-oriented philosophy of Harman which begins as a critical response to process philosophy, asserting the primacy of substance over process and calling for a re-evaluation of agency and of what we might term ‘the integrity of things’. Harman’s critique builds on the earlier “actualist” criticism of Irigaray and Haraway and is likewise aimed at Deleuze. Harman’s object-oriented version of speculative realism is distinctive in its out-and-out resistance to processual ontology. Harman goes on to develop a strongly metaphysical position, which emphasises what he takes to be the hidden and inaccessible depths of all of the objects/entities that constitute the furniture of the world, as well as the inherent privacy and inaccessibility of this ‘withdrawn cores’. Harman’s philosophy gives us an intuitively appealing way of thinking about the boundaries and temporal continuity of objects, but it is no sense positivistic or metaphysically impoverished. Harman develops a strongly metaphysical position that develops a notion of an aesthetic liaison—or aesthetic causality—that takes place between independent and fundamentally unknowable objects. That is to say, for Harman, causality itself is mediated through the operation of an object’s phenomenological ‘sensual surface’.

In order to unpack Harman’s position, it is perhaps worth considering Gere’s (2013) recent comments upon the Arduino-based work of the artist Stanza. In a review of Stanza’s work, Gere suggests that the artist in some way enacts a set of object-oriented philosophical concerns. Thus Stanza’s *Emergent City: From Complexity to the City of Bits* consists of a set of networked miscellaneous objects that despite being laid out in a fashion that is evocative of a city, and appearing to operate in a vaguely systemic fashion, ultimately serves to defy intellectual capture. Gere

stresses that Stanza ‘understands how to use in creative and novel ways a whole range of tools and technologies’, and that as a consequence, his work provides ‘a kind of map of shifting technological realities and possibilities’. Addressing the way in which ‘lights go on and off, and elements revolve at intervals’, Gere emphasises the resonance with Harman’s object-oriented philosophy in so far as:

Things are happening, both on the floor and on the walls, but what they are is not immediately apparent. Far from being a problem I suggest that this opacity is the work’s great strength. Its very refusal of easy understanding is a profound reflection on the world itself, and the degree to which it is available to us.

In the context of his analysis of Stanza’s work, Gere draws attention to the way in which the elements of Stanza’s city-like assemblage are driven by information that is in some sense withdrawn from, or inaccessible to, the audience (the lights and motors within the gallery are triggered by a set of sensors that are recording information from the environment of Stanza’s home)—and this in some sense tallies with Harman’s notion that the objects that we encounter in the world possess a surplus of inaccessible resources—that is, the sense in which there is always more to them than meets the eye. Thus Gere stresses the ‘black-boxed’ nature of the objects that together constitute Stanza’s city and suggests that it is the operation of this inaccessible surplus that perpetually confounds our reading of the work.

However, if Stanza’s work could be said to enact Harman’s philosophy of intractable, withdrawn entities, it could also be said to enact some of its tensions or problems. This becomes most apparent when Gere addresses the issue of the relationality of objects. Thus Gere explains that everything ‘can and does communicate with everything else’, but that much of this communication ‘is not easily available to human subjects’.

The keyword here with respect to understanding Harman’s position is ‘communication’ as opposed to ‘connection’ and the subtle differences in meaning between these terms highlights a particular disagreement between process and object-oriented philosophies. Gere’s choice of the term ‘communication’ is apt but there is a sense in which it obscures one of the most counter-intuitive aspects of Harman’s philosophy, which concerns the tension between the notion of self-contained, independent objects and the possibility of their interaction.

12. Evaluating tensions between object- and process-oriented ontologies

Harman’s position is distinctive in so far as he can be taken as developing a critique of Deleuze, which contorts a number of Deleuze’s processual insights in order to construct a rival metaphysics of objecthood. Initially, with his observation that we need to take objects seriously, Harman appears to emphasising their agency (a la Irigaray) or to be cutting through what is sometimes taken to be, despite its professed materialism, the otherworldly, philosophically idealist aspect of Deleuzian thought—as when the virtual is positioned as an inaccessible realm that conditions and produces the phenomenal actual (this is the basis of Haraway’s critique). Interestingly, when taken out of context, the arguments of Haraway and Irigaray have a certain ‘back to basics’ positivistic ring that seems prohibitive of metaphysical enquiry. Harman on the other hand, as a speculative realist, embraces a fully metaphysical realism, and ultimately produces a more convoluted and ethereal picture of reality than that of Deleuze—a self-proclaimed ‘weird realism’ (Harman 2012) that is at the very least as strange as Deleuze’s philosophy with its virtual–actual distinction.

Harman’s motivation with his object-oriented ontology is to secure a place for the agency of individual things alongside their privacy and internal surplus. Harman sees this state

of affairs as a necessary condition for the institution of change in the world. That is to say, for Harman it is the operation of this interior surplus that is ultimately responsible for the change and transformation of things. Arguably however, in the construction of his own philosophy, Harman simply reconfigures the central Deleuzian dualism of virtual/actual, proposing instead a dualism of real/sensual object (Shaviro 2014). Thus Harman might be said to recast Deleuze's ontological problem as opposed to resolving it in any genuine sense. Harman claims that Deleuze's relational philosophy has no means of accounting for change in the world (Harman 2012), suggesting that if every entity is constituted and therefore exhausted by its relationships then there is nowhere from which novelty might emerge (Harman 2007). Harman's critique, however, focuses upon a rather narrow range of the rich spectrum of relation that is operative in Deleuze's writings—dwelling for the most part upon the syncretist and eternalist conception of relation that is most prominent in *The Logic of Sense* (Deleuze 1990) and in his book on Leibniz, *The Fold* (Deleuze 1993). However, there are a number of alternative approaches to this concept that can be located within Deleuze's corpus. There is, for example, a genetic, differential and productive conception of relation at work in *Difference and Repetition* (Deleuze 2001) as well as a more pragmatic, overtly political sense of relation or environmental relationship that is developed in his collaboration with Guattari (Deleuze and Guattari 2008). Tellingly, Deleuze's rather diverse speculations on the concept of relation share an instrumental unity in so far as they each express, in their own distinctive fashion, a set of process-philosophical concerns with the primacy of becoming and the production of the new. Key to Deleuze's genetic conception of change is the role of creative tensions that arise through the confrontational interplay of differential flows, or fields of force. Thus, Deleuze's virtual seems in many ways

comparable to Harman's notion of an object's withdrawn 'molten core'—each presenting a picture of an at once dynamic and inaccessible surplus that is ultimately productive of change.

Consideration of the concept of relation in Deleuze's and Harman's philosophies draws attention to a certain more generalised paradox of relational constitution. That is to say, if for Deleuze the hyper-material connection of things results in a problem of individuality or differentiation, then for Harman the hyper-integrity of individual objects results in an inverse problem of communication or influence.

The respective difficulties of Deleuze and Harman's philosophies can be seen to arise out of a common problem of interaction between realms that are presented as being in some sense separate, withdrawn or distinct. We have seen how, for Deleuze, there is an issue concerning the relationship between what he positions as an in some sense illusory, actual, phenomenal world and how this might relate to the workings of a more primary, relational and energetic 'virtual' plane. For Harman, however the problem is more extreme. That is to say, if we follow Harman's positioning of objects as self-contained substances through to its philosophical conclusion, a more complex problem of interaction would seem to arise. This is because, in Harman's, at once pluralistic and self-contained actualism, objects, by virtue of their intrinsic separation from others, seem only one step away from becoming entirely detached worlds-in-themselves—and this would be in line with the philosophical definitions of substance that tend to stress substantial self-sufficiency. Accordingly, this gives rise to a number of problems. Firstly there is the issue of interaction between what is 'withdrawn' and what is 'present' with respect to any given object, which as we have seen is in some sense analogous to Deleuze's problem of virtual-actual interaction. Secondly, however, there is a not unrelated and equally serious problem concerning the interaction between actual, but

nevertheless fundamentally separate entities—a problem concerning the way in which individual entities communicate with, or causally influence one another.

13. Harman's aesthetic causation

Harman's metaphysically elaborate solution is to suggest that all of the entities in the world confront one another phenomenally in a mediated fashion through the production of a series of 'noisy' and limited 'sensual' surface-objects—and it is this imagistic liaison that provides the basis for an aesthetic mode of causal interaction (an interaction of appearances). For Harman, individual things (whether human, non-human, organic or inorganic in character) are capable of influencing one another but only through a kind of aesthetic allure. Thus there is a kind of tragically beautiful aesthetic causation that could be said to be operative in Harman's ontology—Harman's objects constantly tantalise and subject one another to provocation—but nevertheless remain fundamentally separate in their withdrawal. Arguably however, with this notion of vicarious causation Harman introduces a ghostly kind of relationality—the things of the world do not straightforwardly connect, but they are nevertheless 'touched' and 'moved' through their aesthetic interaction (Harman 2007).

If Harman were consistent in his account of independent objects or substances, the idea of a single common world populated by discrete entities would seem to fragment into a picture of a multiple, hermetically sealed entities that are perpetually implored by phenomenal appearances to subject themselves to change. In his account of substance and relations, we can witness Harman wrestling with this view. On the one hand he suggests that through the vehicle of intentionality (purposive inter-object engagement), 'shafts or freight tunnels are constructed between objects that otherwise remain quarantined in private vacuums' (Harman

2007), whilst on the other he explains that 'objects confront one another only by proxy, through sensual profiles found only on the interior of some other entity'. The first of these alternatives implies a kind of ontological connection, but one that sits awkwardly with Harman's more generalised picture of purely imagistic liaison. The second is equally curious and somewhat paradoxical in so far as it has an idealistic or even solipsistic tone, whilst nevertheless suggesting a massive proliferation of 'intentional' objects. Taken together, these rather different conceptions of causal or communicative interaction seem to push against one another and this ultimately serves to generate further complications—that is to say, the more Harman addresses the problem of communication, the more prismatic and fragmented his world would seem to become.

14. Ethical connotations and applications

Ultimately both the philosophies of Harman and Deleuze have a predominately aesthetic and affective orientation—each possessing an at once material and semiotic character. However, with respect to this debate, Hassan's (1987) distinction between modernist paranoia and postmodern schizophrenia might be said to loom large—that is to say we might draw an interesting distinction between Harman and Deleuze's philosophical positions along the lines of introversion and extroversion. To elaborate a little, there is a sense in which we might describe Deleuze's philosophy as generous, extravert and life affirming in so far as we are counseled by Deleuze to embrace difference and to experiment with the intensities of living. For Harman, on the other hand, a kind of phenomenal glamour or subterfuge dominates in so far as all causation has an aesthetic quality and a somewhat fraudulent edge. That is to say, embracing Harman's position, we find ourselves petitioned by a flood of appearances that serve to obscure and conceal the objects that

ultimately stand as their ground. As a consequence, there is a sense in which this might be said to foreground questions of ethics and how we are to live.

The philosopher May (1997) once criticised Deleuze on the grounds that his philosophy was totalitarian and foundationalist in character, in so far as it attempted to encode the play of difference at an unassailable material level by effectively ingraining it in matter. Deleuze's strategy is of course paradoxical—employing a material principle of difference as a foundation, with the intent of establishing perpetual unsettlement. Placing his criticisms aside, however, May goes on to suggest that there might be a role for Deleuze's idea of the Virtual in so far as it could serve as an encoded ethical or political commitment, and thus might stand an idea that could coordinate one's activity—or the activity of a group. This provides an avenue for considering the ethical consequence of Deleuze and Harman's philosophies. We have seen how, when embracing Deleuzian ideals, there is always potential for social transformation and institutional change—but that there is also a sense in which we must give *ourselves* up in the process of resistance. For Harman, on the other hand there appears to be space for entrenched individual commitments—but we must allow for similarly intractable commitments with respect to our opposition. Thus it is perhaps the tone of Harman's philosophy and its practical application—as opposed to any metaphysical detail—that invited Shaviro's comments concerning its alleged tendency towards stasis. However, Harman is not alone here—we have seen how Deleuze's position is likewise capable of fostering paradoxes that might be generative of political apathy. It is perhaps for this reason that both Shaviro and Harman grudgingly acknowledge one another's criticism and reach for a (remarkably similar) mid-ground position—and this is no doubt itself testament to Shaviro's comment that the difference between them is really one of emphasis.

15. Conclusion

In this seeming standoff between deceptive-authenticity and connective-mutation, I am, for a number of reasons, ultimately inclined to side with the more transformative, post-structuralist, process-philosophical orientation of Deleuze. Firstly, we have seen how process philosophy asserts the primacy of movement and the absolute ontological priority of change—and whilst it seems clear that there is a sense in which stasis might be reduced to movement (a fast enough vibration results in apparent solidity of form), it is rather less clear how movement might be reduced to any form of stasis, without a significant metaphysical change of gear (and no small amount of special pleading). Object-oriented ontology's emphasis upon the integrity of things would, however, seem to lean towards the latter position (as is evinced in Harman's notion of withdrawn essential cores, and in Bogost's emphasis upon the value of the functional modelling of how things proceed) and it is this aspect of speculative realism that would seem to have featured most prominently in Shaviro's critique. The situation becomes further complicated when we consider the way in which Harman disputes Shaviro's claim that his object-oriented ontology should be considered a philosophy of stasis. That is to say, we have seen how the withdrawn surplus of entities that Harman ultimately invokes to explain such change embodies both a structural similarity and a similar problematic to that which accompanies the Deleuzian virtual/actual distinction. Lastly, the notion that process philosophy has no resources with which to address 'objects' or political agency is simply misguided—as Rescher (1996, 98) has noted, the macrostructures of process philosophy can be considered meta-stable constancies—rhythmic entities which are functional and effective but nevertheless contingent in nature. We have seen how the porosity of process philosophy and its emphasis upon transformation confers a certain power to cross-modalities and scales. As a

consequence, there is a sense in which it seems able to encompass all of the new materialisms—be they angular, intensive, biological, technological, epistemological or ontological in character—and this need not exclude Harman’s object-oriented ontology if we recognise the dynamism of his concealed ‘molten’ cores, and if we are allowed to factor in his philosophy’s rather spectral, or phantom sense of relation.

In closing it is worth returning once more to Banzi’s notion that the Arduino board might be considered a means of ‘scratching your own itch’. We have noted the curious interplay between the material and the affective in relation to the processes of ‘scratching’ and ‘itching’ which from the perspective of processual thinking would seem to result in a situation where neither the scratch nor the itch has causal priority. We have likewise seen how the apparent privacy implied by Banzi’s statement serves to obscure the broader, more pervasive sense of relationality that would seem to condition the Arduino project as well as the rich sense of innovation that was so prominent throughout Banzi’s talk. Indeed, the success of the Arduino stands as a testament to the way in which its makers evidently know (and live) networks on so many levels (be they technical, material, creative or semiotic in character). Earlier we drew attention to the rich spectrum of relation that is operational across Deleuze’s various writings and the way in which they address a range of ontological scales and strata (as if each work had been written for a different philosophical audience). Arguably, however, common to all of Deleuze’s writings is a stress upon the vitality and dynamism of relations (surely the very essence of a network) which points to the idea that, as Peter Hallward has suggested, we should consider ‘Being’ itself as creativity. From this perspective, the ontological status of the Arduino is perhaps less important than its role in constituting, animating and reanimating networks through the production of new relations. Writing on technology in his recent *Design as Politics* Tony Fry warns of its coercive and reductive

aspects, drawing the reader’s attention to the sinister way in which technological artefacts ‘once designed, continue to design’. In contrast to Fry’s bleak vision of technological determinism (that is for the most part focused upon a global consumer context), Arduino offers a vision of technology that, in its affinity with maker and activist culture, is predominately productive and vitalist in character. With this technological vitalism in mind, we might subvert Fry’s designerly scepticism to suggest that the most distinctive quality of the Arduino project has been the way in which once designed it began to *sign*—to draw (human and non-human) actors into its network(s), fostering new relations and curious alliances—perpetually facilitating new ways to scratch and new ways to itch.

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