When making becomes divination: Uncertainty and contingency in computational glitch-events

Betti Marenko, Central Saint Martins, University of the Arts London, Granary Building, 1 Granary Square, London N1C 4AA, UK

This article investigates those aspects of computation that concern uncertainty, contingency and indeterminacy. Starting from a critique of current dominant models of computation, and drawing on the philosophical notions of the virtual and the event, uncertainty, contingency and indeterminacy are proposed as virtualities that express the ongoing differentiation of digital matter. On these grounds, the glitch is reframed as an event capable of revealing the potential of the digital in processes of computational making. Ideas concerning the incomputable and non-human intelligence of the algorithm underpin this argument. Finally, it is proposed that intuitive and uncognitive modes of apprehending digital making operate as forms of divination that capture the unprogrammed unfolding of matter.

Keywords: philosophy of design, computational models, digital design, design processes, uncertainty

> Malfunction and failure are not signs of improper production. On the contrary, they indicate the active production of the 'accidental potential' in any product. The invention of the ship implies its wreckage, the steam engine and the locomotive discover the derailment.
>
> Paul Virilio
> *The Accident of Art* p. 2

> The reproducibility of the machine is not a pure programmed repetition. The scansions of rupture and indifferentiation, which uncouple a model from any support, introduce their own share of both ontogenetic and phylogenetic difference. It is in this phase of passage to a diagrammatic state, a disincarnate abstract machine, that the 'supplement of the soul' of the machinic node are distinguished from simple material agglomerates.
>
> Félix Guattari
> *Chaosmosis. An Ethico-Aesthetic Paradigm* p. 42

Corresponding author:
Betti Marenko
b.marenko@csm.arts.ac.uk

www.elsevier.com/locate/destud
0142-694X *Design Studies* **41** (2015) 110–125
http://dx.doi.org/10.1016/j.destud.2015.08.004

The way in which a society organizes its systems of intuition - its science, its philosophy and its technics — is in every manner a political one.

Sanford Kwinter
The Computational Fallacy p. 212

This paper aims to problematize the relationship between computation and making by bringing to the fore the uncertainty, contingency and indeterminacy that are embedded in digitally-driven processes where both computation and making come together. This paper argues that uncertainty, contingency and indeterminacy should be taken as virtualities — modes of reality implicated in the emergence of new potentials, producing actual experience (Deleuze, 1991). As such, their constitutive role in digitally mediated processes of making is assessed in the field of computational design and in particular in the new field of computational making, understood here as a way of looking at the digital as a type of making activity not restricted to digital fabrication but encompassing embodiment, sensorial participation and the situated apprehension of materiality.

Against the view that equates the digital with a programmed determination of routine execution, this paper aims at theorizing the un-programmed data-matter recombinations and disruptions taking place in practices of making that are enabled by computation, for instance, the digital fabrication of physical artefacts. If the power of algorithms lies in their systemic, logical and routine execution by means of a linear and causal performativity (Berlinsky, 2000), not all algorithms however behave in this way. Some are inductive, exploratory and generative, and their outcomes cannot be fully predicted. Instead, they operate by opening spaces of inconceivable potential (Terzidis, 2003), and this points precisely to what, for Deleuze, is the virtual: the repository of manifold potential that can be actualized (Deleuze, 1991, 1994, 1999). Thus, the actualization of the virtual — the change that the virtual produces as a force that inserts itself into (and breaks apart) concrete reality — is to be understood not in terms of things, but in terms of events.

On these grounds, I introduce the notion of *glitch-event* to map the unpredictable and unexpected irruption of the virtual in computation-driven processes of design and making. It is argued that insofar as *glitch-events* are the by-products of the mutual modulation and differentiation of analogue and digital, then they can be apprehended via material intuition as data-rich divinations of possible futures beyond cognition and control. To articulate this argument, which is also underpinned by recent scholarship on computation and algorithmic culture (Parisi, 2014a, 2014b; Parisi & Portanova, 2011), the paper begins by taking the glitch as paradigmatic of uncertainty and indeterminacy at their extreme, and by reformatting it as an event. Then, it examines ideas

around the non-human intelligence of algorithmic differentiation — where differentiation is drawn, again, from Deleuze, as the transformative potentials inherent in things (Deleuze, 1994). Finally, the paper discusses the role of risk in digital craftsmanship, and presents intuitive apprehension as the key response to the challenges of computational making. Intuitive apprehension is suggested as a divinatory practice, which evokes not only the uncognitive, the tacit and the non-rational in modes of producing knowledge, but also, following Deleuze, proposes a way of grounding a new design ethos for possible future creations (Deleuze, 1990: p. 163).

1 *From glitch-as-accident to glitch-as-event*

Notwithstanding its genesis, source and location — whether internal (algorithmic sequences) or external (input data), human (programmers, users) or machine (hardware) — the glitch is here conceptualized as the tangible and visual manifestation of something unexpected: the irruption of the unplanned (Virilio, 2003; Virilio & Lotringer, 2005). In digital culture the glitch has been described as 'an artifact resulting from an error' (Moradi, Scott, Gilmore, & Murphy, 2009: p. 8), signalling something gone astray in the works of the machine: the machine caught in the act of revealing itself. As such, the computer glitch is an event equally maddening and enchanting: maddening, because it disrupts expected and predictable sequences; enchanting, because it offers a glimpse of something that is usually hidden behind the screen (Marenko, 2014, 2016a). In breaking the spell of the interface, in shattering its black mirror, the glitch discloses aspects of machine operationality (and disarray) not normally witnessed or contemplated. The glitch is therefore double-pronged. It is 'accident, chaos or laceration' (Menkman, 2011: p. 29), but also a sign of portent that emerges from the depths of the machine and seems to formulate idioms that are not exclusively, not necessarily human. Put differently, the glitch is a procedural stutter whose broken utterance speaks of other, entirely non-human worlds, revealing a machinic agency grounded in the pervasive march of algorithm–driven thought (Parisi & Portanova, 2011). However, if the glitch is first and foremost an 'uncanny or overwhelming experience of *unforeseen* incomprehension' (Menkman, 2011: p. 30), it is also an act of subversion. The machine now dictates the rules, rather than obeying them. Within this crumbling of expectations — the machine no longer behaves how it is supposed to — the glitch can be read as the captured expression of the non-humanity of the machine.

On these grounds, in the context of this paper, the significance of the glitch is stretched further, going beyond its role in affirming a counter–aesthetics of destructive generativity with the power to disrupt the perceptions and modes of understanding that are interface's direct filiations — error and noise being always constitutive of any form of communication (Parikka, 2011). Rather, the glitch becomes the tangible, yet *undesigned* (Marenko, 2016b) evidence of the autonomous capacities of digital matter. Broadly, the glitch is now

intended as the potential of an unexpected openness traversing digital materiality. As such, it is taken as paradigmatic of the narratives of uncertainty discussed here.

2 *The indetermination of virtual is not accidental*

As Félix Guattari (1995: p. 42) exhorts us in the epigraph at the beginning of this paper, the systemic organization of algorithm-driven digital machines should be understood as giving rise to differentiation precisely because of its non-humanity. In other words, the digital should be recognized as affording, and manifesting, an ongoing differentiation — the coexisting number of paths not taken yet, unfolding into actualization and resulting in the production of tangible reality.

The notion of the trivial machine — a machine whose behaviour is predictable because there is a linear relation between its inputs and outputs — is useful here as it underpins the current configuration of digital technologies. Drawing on cybernetician Heinz Von Foerster, architecture theorist Stephen Gage (2008) describes its counterpart, a non-trivial machine, as 'a trivial machine with a further, *unknown* machine inside that modifies the output in an *unpredictable* way [emphases added]' (Gage, 2008: p. 20). This irruption of unpredictability produces wonder and delight, says Gage. But there is more. This unpredictability should be taken as signalling the extent of an unknowable digital potential.

On these grounds, what if the glitch was rethought outside the paradigm set by trivial machines? What about errors generated not by the execution of wrong instructions, but as the result of valid instructions performed in situations that are unpredictable because they are continuously modulating and shifting? An example of this is given by online games where there is room for errors made by the user (Krapp, 2011). Indeed, a 'playful sense for potential deviations and alterations' (Krapp, 2011: p. 76) is an essential part of gaming, as the very opposite, or absence of, necessity. Properties emerge that are not already written in the lines of code that make up the game. The contingencies revealed in the opening of spaces of possibilities, in the manifestation of an otherwise potential, in the interstices of the present, are what allows the irruption of the virtual.

Gilles Deleuze's thoughts on the virtual and on differentiation (1994, 1999) are particularly illuminating here. He describes the virtual as a mode of reality concerning the emergence of the new, and differentiation as the process by which the virtual actualizes itself. The undisputed reality of the virtual concerns change, the coming event and the not-yet (Deleuze, 2001; Massumi, 1998). Now, the process by which the virtual becomes actual (actualization) happens through divergent lines of differentiation that are not pre-given or ready-made, but are created as differentiation takes place. It is a differentiating-as-it-happens type of process that manifests the event, and

the fundamental newness each event brings. It is important to note that the actual does not resemble the virtual from which it emerges (Deleuze, 1991). This lack of resemblance denotes the impossibility to predict the outcome of the process, and it is precisely this indeterminacy that means that only a differentiation-driven creation can be genuine creation. In other words, it is this indeterminacy that unlocks unpredictable events, that affords the not-yet, that engenders the new. But, to say that differentiation is unpredictable does not mean to say it is accidental. On the contrary, the unpredictable and the indeterminate, insofar as they constitute the essence of the event, are the negation of the accident. Deleuze is clear on this point: 'the event is not what occurs (an accident), it is rather inside what occurs' (Deleuze, 1990: p. 170). This point helps to clarify how unpredictability should be disengaged from the mere accidental and taken instead in its own right as productive of the not-yet. It also offers a robust underpinning to the shift from glitch-as-accident to glitch-as-event proposed here.

The questions now are: How can this notion of indeterminacy be deployed to understand aspects of performativity in computational making? Can the digital be framed as a potential openness towards differentiation? To investigate these issues it is necessary first to examine ideas around algorithmic intelligence.

3 *On the intelligence of the algorithm*

Digital media theorist Luciana Parisi (with Portanova, 2011, 2014a, 2014b) has written extensively about the status of the algorithm in architecture and interaction design, postulating that algorithmic computation is an autonomous mode of thought. In their discussion of glitch aesthetics, Parisi and Portanova (2011) suggest that the code is 'not a pre-set form of instruction, but is rather continuously produced from within computational processes' (page not given). While current computation theories tend to measure the validity of code by its effects, performativity and functionality, and focus mainly on the expansion of the human sensorium and affects induced by digitalization, Parisi and Portanova argue for a potential autonomy of code that refutes certainty and expresses instead the incomputability of algorithmic machinic thought. In other words, algorithms possess a pure potentiality, an inherent incompleteness and uncertainty that, as I argue here, also becomes constitutive of computational making processes.

Not only does this position overturn the dominant associations of computation with interactivity, communication and sociality, it also opens up new ways of thinking about computational making as a process where uncertainty is crucial. Framed in this way, uncertainty impacts the role of designers, in particular their attendance to the risk involved, and demands a reassessment not only of their culturally, and socially-constructed position, but, especially, of the set of skills they need to engage with increasingly hybridized forms of practice.

Digital performativity and functionality articulate a 'doing by coding' where effects are continuously being produced by coding's own processing, rather than via pre-set instructions. Thus, there is something within algorithmic procedures that cannot be exhausted by their formulation, no matter how complex or elegant. This is the incomputable (and the randomness) at the heart of current computation — where randomness is defined as 'patternless data bursting with algorithmic sequencing' (Parisi, 2014a: p. 416). If we accept Parisi's idea that digital algorithms are an autonomous mode of thinking, designing spaces that may never exist, and may never be experienced, this also implies that we are already beyond digital blueprinting, representation or simulation. In other words, algorithm-constructed realities that cannot be experienced physically 'announce the speculative power of soft thought, with metamodelling ready to design spaces that are not yet and may never be lived' (Parisi & Portanova, 2011). The notion of metamodel is drawn from Félix Guattari. Unlike a blueprint, a metamodel is a diagram that challenges the priority of the empirical by building a reality that exceeds what can be experienced physically, therefore *redesigning* the relation between form and abstraction. For instance, in physics experiments, knowledge comes not from empirical evidence but from abstractions and thought diagrams that, far from representing reality, constitute their own reality (Parisi & Portanova, 2011).

Thus, the 'speculative power of soft thought' foregrounds the shift to a condition where computation is acknowledged as a pure event of contingency, infused with elements that are incomprehensible by and independent from the human mind. Contingency is taken here as a force to work with or, to borrow philosopher Robin Mackay's expression, an 'anonymous material' that works with us and *through* us, 'the attempt to think events that take place but *need not take place*: events that could have been, otherwise' (Mackay, 2011: p. 1). In this sense, the 'soft thought' paradigm postulates the existence of modes of thought beyond or below the mind model, where digital processing is 'infected with the virtuality of incomputable information' (Parisi & Portanova, 2011), therefore bypassing design blueprint, representation or simulation. Instead, what digital algorithms do is *make* — by continuously modulating contingent electronic, bio-physical and chemical data. The machine is not simply hosting a code that carries and executes instructions. It is also now autonomously proceeding by modulating sequences of data extracted from the environment alongside its own generative processes.

> Computational design thinking corresponds to the algorithmic selection and evaluation of infinite amounts of data, making decisions and generating new solutions. This involves not only the computation of physical data, but more importantly their conceptual prehensions: the capacity of rule-based functions to counteract the physical aggregations of data by adding new algorithmic patterns to what already exists (Parisi, 2014a: p. 424).[1]

On these grounds, it can be argued that computation acquires a new dimension unhinged from reason and irreducible to the human mind, where uncertainty is not accidental but constitutive; not dependent upon physical contingencies but inherent. What we have here is the ambitious project of developing algorithms as a non-anthropocentric mode of thought — an asocial and a human mode of thinking. This is a novel way to think about the incommensurability (to human scale) of computational power and the acceleration of automation, and to use this model to reframe human inability to anticipate the outcomes of digital processes — which is what ultimately furnish them with unpredictability and indeterminacy (Kolarevic, 2010; Terzidis, 2003). One must be cautious, however, not to conflate this nonhuman (or posthuman) perspective — and especially the potential for speculations in the fields of design theory and practice it contains — with a renewed form of techno-determinism. This would not only discount the originality of an approach that acknowledges the impact of non-human forces on humanity, it would also miss the opportunity to develop a new model for the understanding of the relationship between human and machine, one not necessarily rooted in social constructivism, but recalibrated on their co-evolution. French philosopher Gilbert Simondon's idea of technogenesis (the genesis of technical objects) is particularly illuminating here. Whether common artefacts, intelligent machines or digital devices, technical objects for Simondon are the temporary concrete expression of an evolution, as they emerge spontaneously via a morphogenetic process that does not fully depend on either natural processes or on human design. Objects acquire an internal coherence that propels them beyond the intention of their inventor or designer. Notwithstanding the fact that they are designed and made by human beings, technical objects have, therefore, a life of their own (Schmidgen, 2012). The implications of this ontogenetical shift are relevant to my argument as they underline the extent to which the genesis of technical objects is fully integrated into culture — humans make machines as machines make humans, and they both participate in the becoming of their milieu.

To go back to Parisi's argument, what is also important to remark is that it subtly unhinges algorithmic thought from materiality. The shift she describes, pertinent here, is 'from digital simulations of form-finding to the generation of materially-driven models' (2014a: p. 407). That is, the shift is from a deductive, top-down model of form-finding where algorithms produce simulations of the behaviours of matter, to an inductive, emergent model grounded on the capacities of matter and the physical properties of elements, thus entirely matter-driven. Framed as indicative of technocapital acceleration of automation this shift however indicates the irreducibility of 'an algorithmic evolution equipped with its own physical and conceptual levels of order that are *not one with matter* [emphasis added]' (2014a: p. 407). This striking proposition counteracts what appears to be the ontological implications of the acceleration of automation, that is, the production of a 'computational design thinking

embracing the seamless fusion of thought and matter' (2014a: p. 407). For Parisi, this perspective risks plunging computational design thinking into an 'idealistic materialism according to which the relation between computation and reason is mediated or to some extent caused by material data' (2014a: p 408). The problem is that a perspective too focused on the materiality of the process tends to disregard the pure abstractions implicit in algorithmic processing, patterning and movement that are not necessarily associated with experience and perception. Digital design theorist Kostas Terzidis (2003) makes a similar point in his discussion of algorithmic structures that generate abstract patterns unhinged from human experience and perception (2003: p. 69).

This is not however a rejection of materiality, but an attempt to radicalize, and acknowledge, the implications of algorithmic processes whose productions do not necessarily coincide with matter, but produce their own, uncharted, modes of thinking. Put differently, there is something within algorithmic procedures that is not exhausted by their formulation, or by the interaction of local parts. The key implication is that the uncertainty of the incomputable is now located at the heart of computational processes, therefore directly affecting processes of computational design and, even more so, processes of computational making. Crucial for my argument in favour of intuition, I take this as an exhortation to shift from a linear logic to marginal zones of attention, indirect cognition, empathic tools and intuitive modes of understanding the digital taken as a potential openness towards differentiation.

4 *Digital* élan vital*, diagrams and divination*

In the online article titled 'Crash, or the digital *élan vital*. Virtuality, differential ontology and deterministic digitality'[2] the expression 'digital *élan vital*' is introduced to indicate the movement or impulse toward differentiation found in processes of algorithmic computation. This is drawn from philosopher Henri Bergson's notion of *élan vital* – the vital impetus propelling differentiation – for Deleuze, a virtuality in the process of being actualized, a simplicity in the process of differentiating, a totality in the process of dividing up (1991: p. 94). If we postulate internal difference as tending towards indeterminacy, then the unpredictable and the indeterminate become the engine of algorithmic differentiation. Seen through this lens, the irruption of *glitch-events* signals precisely this ongoing potential for digital differentiation. As an event always inscribed in the horizon of possibilities, immanent in time (what might happen), the glitch is a manifestation of the virtual and its unknown ability insofar as it is the by-product of differentiation. But this is not all. The glitch is not just a machine error, nor a symptom signalling the need for technical normalization, nor just the key to a new aesthetic of programmed indeterminacy. Rather, it is the whisper of the machine's own incomprehensible, non-human thought. This is a further articulation of the glitch as an event whose presence indicates a non-human elsewhere. It is precisely its location at the

boundary between the known and the unknown that turns the glitch into a divining practice (Cascone, 2011). For sound artist Kim Cascone the glitch is a portal to otherness, to another, non-manifest reality governed by different time and space coordinates. In other words, the glitch is a device for divination, like those medieval divinatory media such as omens, blessings and prophecies that were used to access a supernatural realm.

As it is argued below, if differentiation is indetermination, then it affords apprehension via non-cognitive tools, intuitive formulations, archaic and minor intelligences, and divination. Deleuze writes briefly about divination in his discussion of the event in Stoic philosophy. Divination is 'the relation between the pure event (not yet actualized) and the depth of bodies, the corporeal actions and passions whence it results' (Deleuze, 1990: p. 163). Put differently, divination sets the ground for creation by seeking in the emergent forms the seeds of forms yet to come, of future actualizations and differentiations. In this sense divination – 'the art of surfaces, lines, and singular points appearing on the surface' (Deleuze, 1990: p. 163) – is a diagram that connects the known to the unknown (Ramey, 2012). Any diagrammatic operation of divination captures (and wills) possible events by impacting on how present responses are selected, designed and implemented. The relationship between divination and diagrams is most significant in that diagrams articulate the conditions that make possible conceptual creation and the manifestation of new expressions – but do not determine directly the outcome. Again, indeterminacy is key. Diagrams are the 'emergence of another world' (Deleuze, 2003: p. 71), they are populated by asignifying traits that are 'irrational, involuntary, accidental, free, random' (Deleuze, 2003: p. 71). Their function is to suggest possibilities of fact, is 'to cast a concrete, aleatoric structure that may or may not contribute finally to the finished composition of the actual work but the mutual determinations of whose elements provide virtual conditions or openings for its creative production' (Gangle, 2010: p. 80). What diagrams produce, then, is a material entanglement with a concrete yet unknown future. The relationship between diagrammatics and divination is clear: 'all genuine diagrams "divine", in the sense that they *prophesy* worlds by presenting a synecdoche of the imperceptible forces animating percepts and affects' (Ramey, 2012: p. 164).

On these grounds, what emerges is the possibility of interpreting the glitch-event (articulated so far as the openness of digital potential and its algorithmic autonomous trajectory) as a form of diagrammatic divination. It is at this point that issues of indeterminacy and intuitive apprehension in the context of computational making must be addressed, and in order to do so I turn to the role of risk in practices of digital craftsmanship.

5 *Risk, digital craft and digital intuition*

As it has been increasingly noted (Carpo, 2013a; Kolarevic, 2008, 2010) form-finding is a new discipline where forms are not designed but found by way of

'holistic intuition or intellection, and by dint of a mute and tacit empathy between the maker and the materials being crafted' (Carpo, 2013a: p. 60). Craft and intuition take centre stage over design and calculation, complemented by the power of digital modelling. 'Digital simulation can make and break more models in a few seconds than a traditional craftsmen could in a lifetime, thus making intuitive, heuristic form finding by trial and error a perfectly viable design strategy' (Carpo, 2013a: p. 60). Drawing on David Pye's distinction between a workmanship of certainty and a workmanship of risk, architect Branko Kolarevic (2008, 2010) has articulated the notion of 'digital craft' to emphasize the role of risk and uncertainty within current digitally-enabled practices of making. The parallel is clear. The characteristics of craft — 'deliberate actions based on continuous, iterative experimentation, errors, and modifications that lead to innovative, unexpected, and unpredictable outcomes, discovered in the intertwined processes of conception and production' (Kolarevic, 2008: p. 127) — fit effortlessly digital making. Digital craftsmanship, like any craftsmanship, uses experimentation with its materials, tools and media to pursue *unpredictable* outcomes.

> In contemporary practices that have fully adopted digital technologies into the processes of design and production, digital media is often deployed to *discover* a promising formal configuration or spatial organization. In other words, results of a particular design process are not predetermined or anticipated — they are to be discerned among many alternatives and variations produced in carefully articulated, structured investigations, often in a circular, non-linear fashion. As the unanticipated design outcome hinges on discovery — and the discovery is by no means certain — there is an implied element of risk in the entire process. This notion of risk, stemming from *the inherent lack of predetermined design outcomes*, [emphasis added] is how we could interpret David Pye's work in contemporary context (Kolarevic, 2008: p. 121).

The potential of digital craft lies in the designer's perceptual abilities to intuitively capture, edit and take informed decisions concerning the outcomes of the generative system, a mode pivoting on uncognitive apprehension. Indeterminacy, or better, *precise indeterminacy* — to use Kolarevic's expression (2008: p. 122; Goulthorpe, 2008: p. 128) — becomes a resource that questions and supplants design determinism. Connection to risk, admittance to the unpredictable and the unexpected as forces to work with, intuition-led transformation, all become paramount tools in the arsenal of the digital designer/maker. Not everyone, however, agrees. For architect Scott Marble (2010) the merging of design and production into the common language of digital information — for instance, the way CNC systems afford informed making through a new symbiotic relationship between material and human intelligences means that no drawing or blueprint is needed to formulate a design intention. Thus design intentionality is lost in a neomodernist obsession

with control, optimization and efficiency – a technodigital determinism that ultimately dispenses with risk-taking and uncertainty.

The question now is: how can risk and uncertainty be fostered within processes of computational making in ways that enable the informed guess, the psychophysical agility of thinking whilst doing the 'mental elbowroom' (Ackermann, 2005) necessary to imagine possible alternatives to what is prescribed? The insights gathered so far suggest that the digitally-driven process of discovery associated with the emergence and selection of forms, unanticipated and not predetermined at a cognitive level, is indicative of (and symbiotic with) the autonomy of algorithmic thinking.

6 *Between indeterminacy and precision – examples*

Experimental architect Nat Chard – whose blog is tellingly titled *Drawing Uncertainty*[3] – addresses accurately the creation of 'mental elbowroom' when he describes his drawing instruments as tools for drawing in an indeterminate way with the aim 'to keep meaning alive and open' (Chard, 2011: p. 36). These instruments operate between 2D and 3D, that is, between drawing and making, implementing a practice of designing-as-one-goes-along, whilst manufacturing the tools. Chard makes clear that the sense-making embedded in these instruments is

> not stated, although there are enough provocations for those that engage with the instruments to imagine what it might be. The latent prescription of the instrument is therefore about the structure of making sense rather than the specific content of the object. Instead of being prescriptive, or closing the meaning of things, these apparently didactic instruments in fact aim to keep meaning alive and open (Chard, 2011: p. 36).

Another example, at the intersection of art, architecture and robotics, is given by the research lab and fabrication shop *Greyshed*[4] that uses computation, construction, craftsmanship and design to explore the potential of digital fabrication beyond any forced separation between tangible and intangible. For instance, to explore how the designer can affect in real time robot-led fabrication processes, *Greyshed* has developed an augmented reality interface that allows the user to modify robot toolpaths by tapping on the screen. The operation is scaled down to one command at a time in a 'byte to robot' process, as opposed to a 'file to factory' process, which involves a predetermined batch of commands. This suggests that new forms of digitally-mediated practices of making, far from constituting a move away from human intuition, provide instead 'the potential to bridge the gap between human sensibilities and material properties in the design process, thus ushering in a new kind of craft that is both materially responsive and "highly informed"' (Johns, 2014: p. 217). There is a claim here for the value of intuitive interaction and sensorial engagement in processes of digital making, not in spite of, but *because of* the potential afforded by the digital.

What this points to is a dimension where experimental, experiential and unpredictable elements are inserted in digital processes, disrupting the dichotomy between digital and analogue, material and immaterial. The outcome is a simultaneous meshwork or a *milieu* of human designer, robotic manipulator, computer simulation and material reaction, in which teleology and hierarchies collapse in a flat ontology (De Landa, 2002). This is where design processes can be reimagined as event-driven spaces of contingent occurrences, non linearity, intuition, even ambiguity and contradiction, rather than certainty. By taking the forces of contingency as materials to work with, and, like matter, mutating morphogenetically, it is argued that these are problematizing rather than simplifying forces. They manifest a tension present in the process of design between the desire to capture form on one hand, and the need to acknowledge and work through contingency on the other: a tension between form-capture and the virtual; between problem solving (realm of the possible), and problem finding (realm of the virtual) (Marenko, 2015, 2016b).

These problematizing forces – contingency in primis – should affect design, as they counteract the essence of what design is conventionally taken to be: the intentional planning, the ideal blueprint, even the cunning deceit, as philosopher and design theorist Vilém Flusser famously wrote (1999). Such a conventional view of design can be challenged by insisting on what intuition and contingency bring to the process: the indeterminacy of the *undesigned* at the core of design (Marenko, 2016b).

These ideas-in-the-making are circulating in the world of design from designer Richard Elaver's *Emergent Tableware* and Daan van den Berg's *Merrick Lamp* to artist Roxy Paine's sculpting machines.[5] For instance, Elaver's work explores the transition between the virtual and the physical. While each piece is uniquely generated by code, it is the random insertion of program changes that allows the emergence of variations in form and pattern. Unpredictability becomes a significant part of the process of form generation, while questioning authorship. Van den Berg's *Merrick Lamp* is a mutated Ikea lamp that uses the customization feature of the IKEA's website but with the insertion of a virus that mutates the original lamp templates. This infection is manifest in the final 3D printed outcome: a lamp with cracks and lumps reminiscent of John Merrick, The Elephant Man.

7 Conclusion

The tendency toward a celebration of indeterminacy has been noted and critiqued by architecture historian Mario Carpo who equates it with a resurgence of postmodern thought (2012, 2013a, 2013b, 2014). The emphasis on intuition in the capture of digitally-driven form signals, for Carpo, a dubious vitalistic swerve infused with a post- (or anti-) modernist approach that romanticizes and cherishes non-rational, mysterious and even esoteric forms of knowledge. What is at stake is the extent to which relying on intuition as

a mode of knowing is seen as undermining the capacities, skills and culturally-constructed ethos of the designer as a socialized individual capable of controlling natural forces, of creating the artificial and in so doing of giving a (better) form to the world.

My argument, however, contends that uncertainty and indeterminacy should be read not as a post-modern romantic phenomenon based on a 'neo-technopathetic fallacy' — to paraphrase John Ruskin's expression, but, rather, as emblematic of the broader shift occurring in how computation operates and in how computation is conceptualized as outlined in this paper. It is clear that current computation and accelerated automation produce realities that develop independently from the programmer's intentions as these are formalized in computer programming. The way algorithms extract and process information from data in continuous environmental modulation indicates that even when designers do write the programs, the outcome cannot be fully predicted. As this paper suggests, this lack of predictability is the very condition of computation.

On these grounds, computational making can be framed as a process that affords a double articulation of intuitive apprehension. In other words, intuition here is not merely the intuition proper of a craftsmanship of risk reimagined for the digital age — what Carpo dismisses as a vitalistic mannerism. Instead, I argue that this type of apprehension is signalling something more profound: an intuitive matching of digital making to the randomness that constitutes the core of computation. Put differently, it would be disingenuous to accuse designers of falling for indeterminacy in the name of neoromantic affinities, either with an uncontested organicism in the emergence of form, or with machines seen as extensions of themselves. Rather, the tendency towards indeterminacy and intuition must be taken as evidence of the cohabitation and coevolution of human and non-human material intelligences. The designer embracing intuitive, tacit and empathetic (even sympathetic) knowledge is only responding, as designers do, to the shift in computation outlined above.

In offering a cautious counterpoint to customary celebrations of material computation, Bob Sheil (2012) reinforces this point by stressing indeterminacy as what allows a much needed pause of critical reflection between drawing and making:

> It is the manner in which design information allows for indeterminacy and anticipates the possibility of how it can be made that make it work in the form of a built artifact. The skill in describing architecture before it is built is to make design information that anticipates, rather than dictates, how it is translated through time, site, materials, fabrication processes, assembly and use, and to understand the difference between the first prototype and the last. Without such a critical allowance, the built artefact is no more

than a physical render of a projected image where the exploration of its performance as a construct ceased at the point of simulation (Sheil, 2012: p. 138).

As the techno*milieu* of human and machine undergoes yet another epochal shift, it affects how design operates in the world. Design becomes a reflecting, responsive and problematizing enterprise, not only directed at bettering the environment or pursuing a vague notion of 'wellbeing', but focused instead on the capture of what is already happening, and responding accordingly. Far from being an instance of esoteric affiliation or post-romanticism, an intuitive, uncognitive and material apprehension is the proof of design capturing, as always, stories from the immediate future and giving them a tangible form in the present. With the difference, this time, of doing so in ways that are more akin to divination than to control.

Notes

1. The notion of prehension is drawn on philosopher Alfred N. Whitehead. It indicates a sympathetic connection, a kind of perception, a force that connects things. For a clear articulation of Whitehead's prehension in relation to making, risk and design, see Hugh T. Crawford (2015).
2. http://www.mechanosphere.com/MediaPages/DigitalElanVital04Sep2008.html (unattributed author, no date. Accessed 3 April 2015).
3. http://natchard.com/ (Accessed 3 April 2015).
4. Founded in 2011 by architects Ryan Luke Johns and Nicholas Foley, plus Abraham the robot, *Greyshed* is a garage-based collaboration focused on architectural robotics and design/fabrication workflows. http://www.gshed.com.
5. Richard Elaver's *Emergent Tableware*: http://www.designercraftsman.com/portfolio/algorithmicdesign/1/1.html. Daan van den Berg's *Merrick Lamp*: http://www.platform21.nl/page/3915/en. Roxy Paine: http://www.roxypaine.com/ (All accessed 3 April 2015).

References

Ackermann, E. (2005). Playthings that do things: a young kid's "Incredibles"!. In *IDC 05 proceedings. Interaction design and children* (pp. 1–8).

Berlinsky, D. (2000). *The advent of the algorithm: The ideas that rule the world.* New York: Harcourt.

Carpo, M. (2012). Digital darwinism: mass collaboration, form-finding, and the dissolution of authorship. *Log, 26*, 97–105, New York, Anyone Corporation.

Carpo, M. (2013a). The Ebb and flow of digital innovation: from form making to form finding – and beyond. *Architectural Design (AD), 83*(1), 56–61, Chichester, UK: John Wiley & Sons.

Carpo, M. (2013b). In P. Lorenzo-Eiroa, & A. Sprecher (Eds.), *Digital indeterminism: The new digital commons and the dissolution of architectural authorship, in architecture in formation: On the nature of information in digital architecture* (pp. 47–52). London: Routledge.

Carpo, M. (2014). Breaking the curve. Big data and design. *ArtForum International, 52.6*, 169–173.

Cascone, K. (2011). Errormancy. Glitch as divination. http://theendofbeing.com/2012/04/19/errormancy-glitch-as-divination-a-new-essay-by-kim-cascone/. Accessed 03.04.15.

Chard, N. (2011). Fabricating indeterminate precision. In R. Glyn, & B. Sheil (Eds.), *Fabricate: Making digital architecture* (pp. 32–39). Cambridge, Ont: Riverside Architectural Press.
Crawford, H. T. (2015). Thinking hot: risk, prehension, and sympathy in design. In B. Marenko, & J. Brassett (Eds.), *Deleuze and design* (pp. 84–106). Edinburgh: Edinburgh University Press..
De Landa, M. (2002). *Intensive science and virtual philosophy*. New York: Continuum.
Deleuze, G. (1990). *The logic of sense*. New York: Columbia University Press.
Deleuze, G. (1991). *Bergsonism*. New York: Zone Books.
Deleuze, G. (1994). *Difference and repetition*. London: The Athlone Press.
Deleuze, G. (1999). Bergson's conception of difference. In J. Mullarkey (Ed.), *The new Bergson* (pp. 42–65). Manchester and New York: Manchester University Press..
Deleuze, G. (2001). *Pure immanence. Essays on a life*. New York: Zone Books.
Deleuze, G. (2003). *Francis Bacon: Logic of sensation*. London and New York: Bloomsbury Continuum.
Flusser, V. (1999). *The shape of things: A philosophy of design*. London: Reaktion Books.
Gage, S. (2008). The wonder of trivial machines. *Architectural Design (AD), 78*(4), 12–21, Chichester, UK: John Wiley & Sons.
Gangle, R. (2010). Divinatory chance. *SubStance, 39, 1*(121), 76–86.
Goulthorpe, M. (2008). *The possibility of (an) architecture: Collected essays*. London and New York: Routledge.
Guattari, F. (1995). *Chaosmosis. An ethico-aesthetic paradigm*. Bloomington and Indianapolis: Indiana University Press.
Johns, R. L. (2014). Augmented materiality: modelling with material indeterminacy. In F. Gramazio, M. Kohler, & S. Langenberg (Eds.), *Fabricate. Negotiating design and making* (pp. 216–223). Zurich: GTAVerlag.
Kolarevic, B. (2008). The (Risky) craft of digital making. In B. Kolarevic, & K. R. Klinger (Eds.), *Manufacturing material effects. Rethinking design and making in architecture*. New York and London: Routledge.
Kolarevic, B. (2010). Between conception and production. In P. Bernstein, & P. Deamer (Eds.), *Building (in) the future: Recasting labor in architecture* (pp. 67–73). New York: Princeton Architectural Press.
Krapp, P. (2011). *Noise channels. Glitch and error in digital culture*. Minnesota University Press.
Kwinter, S. (2003). The computational fallacy. *Thresholds – Denatured, 26*, 90–92, (reprinted in A. Menges and S. Ahlquist (eds.) (2011) Computational Design Thinking. AD Reader. Chichester, UK: John Wiley & Sons pp. 211 – 214).
Mackay, R. (2011). *The medium of contingency*. Manchester: Urbanomic and Ridinghouse.
Marble, S. (2010). Imagining risk. In P. Bernstein, & P. Deamer (Eds.), *Building (in) the future: recasting labor in architecture* (pp. 38–43). New York: Princeton Architectural Press.
Marenko, B. (2014). Neo-animism and design. A new paradigm in object theory. Issue 6.2. In L. Atzmon (Ed.), *Design and culture. Special issue: Design, thing theory and the lives of objects* (pp. 219–242). London: Berg.
Marenko, B. (2015). Digital materiality and the intelligence of the technodigital object. In B. Marenko, & J. Brassett (Eds.), *Deleuze and design* (pp. 107–138). Edinburgh: Edinburgh University Press.

Marenko, B. (2016a). 'Filled with wonder'. The enchanting android from cams to algorithms. In L. Atzmon, & P. Boradkar (Eds.), *Encountering things. Design and thing theory*. London: Bloomsbury.
Marenko, B. (2016b). The un-designability of the virtual. Design from problem-solving to problem-finding. In G. Sade, G. Coombs, & A. McNamara (Eds.), *Un Design*. London: Bloomsbury Continuum.
Massumi, B. (1998). Sensing the virtual, building the insensible. Hypersurface architecture. InPerrella, S (Ed.). (1998). *Architectural design (Profile no. 133), 68* (pp. 16–24), 5/6.
Menkman, R. (2011). *The Glitch Moment(um)*. Network Notebooks 04. Amsterdam: Institute of Network Cultures.
Moradi, I., Scott, A., Gilmore, J., & Murphy, C. (2009). *Glitch: Designing imperfection*. New York: Mark Batty Publisher.
Parikka, J. (2011). Mapping noise: techniques and tactics of irregularities, interception, and disturbance. In E. Huhtamo, & J. Parikka (Eds.), *Media archaeology*. Berkeley, CA: University of California Press.
Parisi, L. (2014a). Automated architecture. In R. Mackay, & A. Avanessian (Eds.), *Accelerate* (pp. 401–424). Falmouth: Urbanomic.
Parisi, L. (2014b). Digital automation and affect. In M. L. Angerer, B. Bosel, & M. Ott (Eds.), *Timing of affect. Epistemologies, aesthetics, politics* (pp. 161–177). Zurich and Berlin: Diaphanes.
Parisi, L., & Portanova, S. (2011). Soft thought (in architecture and choreography). Computational culture. *A Journal of Software Studies, 1*. http://computationalculture.net/article/soft-thought. Accessed 03.04.15.
Ramey, J. (2012). *The Hermetic Deleuze. Philosophy and spiritual ordeal*. Durham and London: Duke University Press.
Schmidgen, H. (2012). Inside the black box: Simondon's politics of technology. *SubStance, 41*(129), 16–31, Madison: University of Wisconsin Press.
Sheil, B. (2012). Distinguishing between the drawn and the made. *Architectural Design (AD), 2*(216), 136–141, Chichester, UK: John Wiley & Sons.
Terzidis, K. (2003). *Expressive form: A conceptual approach to computational design*. New York: Spon Press.
Virilio, P. (2003). *Unknown quantity. Exhibition catalogue. Fondation cartier*. London: Thames and Hudson.
Virilio, P., & Lotringer, S. (2005). *The accident of art*. New York: Semiotext(e).