Summary
The notion of ecology not only figures centrally in current debates around climate change, but also traverses contemporary discourses in the arts, the humanities, and the social and techno sciences. In its present reformulation it refers to the multi-layered and multi-dimensional nexus of reciprocities between living processes, technological and media practices, i.e. to the complex relations of human and nonhuman agents. The book Hybrid Ecologies understands ecology as an ambivalent notion, whose multivalence opens up new fields of action and yet, thanks precisely to this openness and vast applicability, at the same time raises questions not least concerning its genealogy. The interdisciplinary contributions seek to explore the political and social effects that a rethinking of community in ecological and thus also in biopolitical terms may provoke, and which consequences the contemporary notion of ecology might entail for artistic and design practices in particular. The present publication is the result of the fifth annual program of the cx centre for interdisciplinary studies, which was conceived in cooperation with the Chair of Philosophy | Aesthetic Theory at the Academy of Fine Arts in Munich.

diaphanes eTexT
www.diaphanes.net

Publication series of the cx centre for interdisciplinary studies at the Academy of Fine Arts Munich

The publications in this series are the results of the cx centre for interdisciplinary studies, which was inaugurated at the Academy of Fine Arts Munich in 2011, of its teachings, its research and its practice projects. The cx takes up questions of current central artistic, scientific and social relevance, so as to discuss them from an interdisciplinary perspective. A major focus herein lies on the dialogue between scientific and artistic approaches, and on the close interconnection of theory and praxis. The programme of the cx is facilitated by the Federal Ministry of Education and Research's Quality Pact for Teaching. After the volumes *Power of Material/Politics of Materiality* (2014), *Fragile Identities* (2016), *The Present of the Future* (2017) and *Real Magic* (2018) *Hybrid Ecologies* is the fifth volume of this series.

Hybrid Ecologies
Susanne Witzgall, Marietta Kesting, Maria Muhle, Jenny Nachtigall (Eds.)

diaphanes

Table of Contents

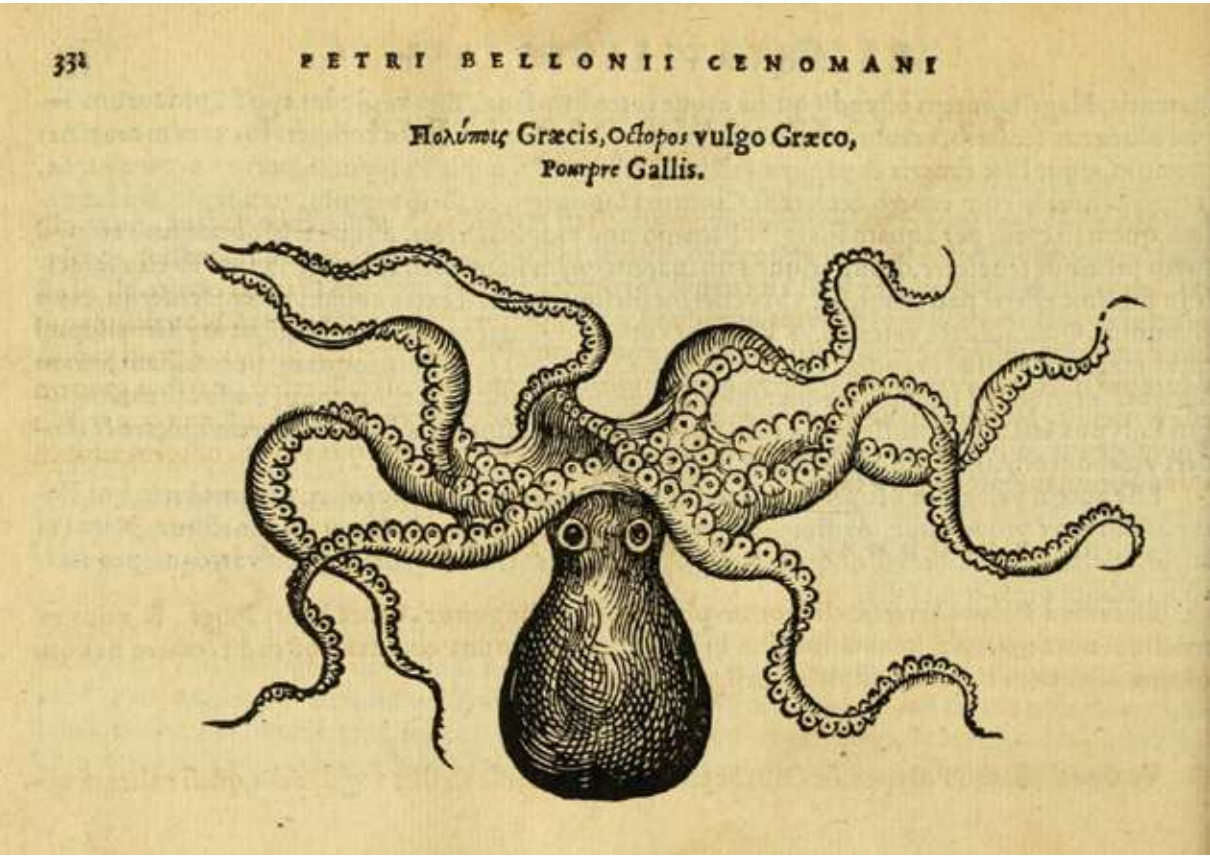

Fig. 1
Octopos vulgo Graeco (illustration by Pierre Belon), from: Petri Bellonii Cenomani, *De aquatilibus, libri duo cum [epsilon, iota] conibus ad viuam ipsorum effigiem, quoad eius fieri potuit, expressis …, Apud C. Stephanum, Parisiis, 1553*, p. 332, fig. 137, Harvard University, Museum of Comparative Zoology, Ernst Mayr Library, Cambridge, Massachusetts.

Future-Crafting: The Non-humanity of Planetary Computation, or How to Live with Digital Uncertainty

Betti Marenko

The age of planetary computation

Planetary computation. An epochal shift rewires humanity by impacting on our capacity to feel, to perceive, to sense and to think. Far from being a mere matter of speed of communication, this change has to do with the creation of new interlocking ecologies where information is sensed and the cognitive, perceptual and affective spheres mutate. Sensation prevails over signification. Data becomes us. Mediation shifts to immediation. This is the Fourth Revolution, when the digital-online world spills into and merges with the analogue-offline world. In this *onlife experience* data is the new currency, code is synchronized to the human and the infosphere becomes synonymous with reality.[1] The proliferation of smart algorithmic environments evolving in real time, the colonization of daily life by social networks, the tsunami of data, the unstoppable googlification of knowledge together create new ecologies of cohabitation and co-evolution of the human with the non-humanity of planetary computation. Given this scenario, two questions emerge as urgent. What is the impact of the ongoing informatization of bodies, artefacts and environments on the whole of human cognition, affectivity and perceptual faculties? What kind of narratives, images and fictions are needed to make sense of the ecologies we now inhabit, which are populated by agents on a continuum between the human and the non-human, data flows, codes, algorithms, and strange entanglements of silicon and carbon?

[1] Luciano Floridi, *The 4th Revolution. How the Infosphere is Reshaping Human Reality* (Oxford: Oxford University Press, 2014).

The indeterminacy of open machines

In the 1980s Félix Guattari was one of the first thinkers to write about the coming 'age of planetary computerization'.[2] Already in 1979 he had declared: 'The computer is effectively on the point of being integrated into a complex of enunciation in which it will become impossible to "separate out" human intervention and machinic creativity'[3] – effectively anticipating the current ecological landscape where the human and the non-human cohabit in unprecedented ways. In *The Three Ecologies* Guattari discusses how the 'acceleration of the technological and data-processing revolutions, as prefigured in the phenomenal growth of a computer-aided subjectivity'[4] would lead to a series of human and nonhuman openings, unfoldings and becomings. Foreseeing the present-day function of computers as vehicles of machinic semiotisation, Guattari heralds the coming 'post-media era'[5] as a remapping of subjectivities thanks to newly formed computerization-driven assemblages. For him the emergence of computer-based practices of subjectification is charged with potentialities: 'One may assume, in this respect, that it is the extension into a network of databanks that will have the biggest surprise in store for us.'[6] Guattari emphasizes the creative and liberating potential of these new subjectivities that, perhaps for the first time in history, would be able 'to lead to something more enduring than mad and ephemeral spontaneous outpourings – in other words, to lead to a fundamental repositioning of human beings in relation to both their machinic and natural environments (which, at any rate, now tend to coincide)'.[7] If subjectivity is produced through large-scale machines including languages, media and technological innovation, then computer technology becomes a non-human component feeding into pre-personal parts of subjectivity.[8] 'Just as social machines can be grouped under the general title of Collective Equipment, technological machines of information and communication operate at the heart of human subjectivity, not only within its memory and intelligence, but within its sensibility, affects and unconscious fantasms.'[9] Put differently, our current eco-technological lives are no longer simply *mediated* by information and computation, but are fully constituted by them. This is how Guattari furnishes us with ways of thinking about new human–non-human ecologies, staying clear of both technodeterminism and technodystopia, while also refuting the naïve notion of machines and technologies as neutral tools. What is emphasized instead is the extent to which planetary computation undermines the structural distinction between machine and cognition, and forces us to reimagine the boundary between human and nonhuman.

> The object is no longer to compare humans and the machine in order to evaluate the correspondences, the extensions, the possible or impossible substitutions of the ones for the other, but to bring them in communication in order to show how humans are a component part of the machine, or combines with something else to constitute a machine. The other thing can be a tool, or even an

[2] Félix Guattari, 'Regimes, Pathways, Subjects', in Jonathan Crary, Sanford Kwinter (eds.), *Zone 6. Incorporations* (New York: Zone Books, 1992). Originally published as 'De la Production de Subjectivité', *Chimères* 4 (1987). A version also appeared in *Schizoanalytic Cartographies* (London: Bloomsbury, 2013) pp. 1–15.

[3] Félix Guattari, *Lines of Flights. For Another World of Possibilities* (London: Bloomsbury, 2016), p. 191.

[4] Félix Guattari, *The Three Ecologies* (London and New Brunswick: The Athlone Press, 2000), p. 38.

[5] Félix Guattari, *Soft Subversions* (New York: Semiotext[e], 1996), p. 106.

[6] Félix Guattari, *Schizoanalytic Cartographies* (London: Bloomsbury, 2013), p. 42.

[7] Guattari 1996 (footnote 5), p. 118.

[8] In Guattari's ethico-aesthetic paradigm the emphasis lies on the machines that make existence possible. While the 'aesthetic' concerns the creation of mutant affects that carry one beyond the familiar and the known, the ethical implications of Guattari's paradigm address the fact that any creation involves responsibility in regard to what is created. As it offers a model for a production of subjectivity beyond dominant equilibria and based on affects, uncertainty, openness, emergence, renewal and creation, it could be understood as a paradigm of liberation.

[9] Félix Guattari, *Chaosmosis. An Ethico-Aesthetic Paradigm* (Bloomington and Indianapolis: Indiana University Press, 1995), p. 4.

> animal, or other humans. We are not using a metaphor, however, when we speak of machines: humans constitute a machine.[10]

The cyberneticization of the world, that is, the introduction of information on a planetary scale, is the key to new modes of sense-making that are contextual, relational and not fully predictable, emerging in the contemporary technological condition.[11] New practices of subjectivity arise from the increasing miniaturization and personalisation of apparatuses; an age of digital ensembles unfolds, characterized by *open* machines and by instability, uncertainty and indeterminacy. In his discussion of the history of technological objects, media theorist Erich Hörl articulates the shift from sense-making as the outcome of subjective acts, to sense 'emerging from the non-signifying collaborative practices of humans, objects, and machines'.[12] The technical object ceases to be instrumental accessory to the establishment of meaning in order to become the hinge of an open, collaborative and relational – even 'post-discursive-meaning' – production of sense. This shift to openness and indeterminacy is what in cybernetics underpins the distinction between trivial and non-trivial machines. While a trivial machine is characterized by a one-to-one relationship between its input (stimulus, cause) and its output (response, effect), and is therefore entirely predictable, non-trivial machines 'are quite different creatures',[13] as cyberneticist Heinz von Foerster wrote:

> Their input-output relationship is not invariant, but is determined by the machine's previous output. In other words, its previous steps determine its present reactions. While these machine are again deterministic systems, for all practical reasons they are unpredictable: an output once observed for a given input will most likely be not the same for the same input given later.[14]

The French mechanologist and philosopher Gilbert Simondon acknowledges the role of indeterminacy in the evolution of machines in a short text on 'Technical Mentality', in which he discusses the openness of technical objects as the condition of their perfectibility.[15] This form of openness whereby the object is worked upon, expanded, amplified and upgraded entails the irruption of the unexpected, the off-grid, the unplanned, the emergent and the accidental in the constitution of machines.[16] In *On the Mode of Existence of Technical Objects*, Simondon reminds us of the crucial role of indeterminacy in this process:

> The true progressive perfecting of machines, whereby we could say a machine's degree of technicity is raised, corresponds not to an increase of automatism, but on the contrary to the fact that the operation of a machine harbors a certain margin of *indeterminacy* [emphasis added]. It is this margin that allows the machine to be sensitive to outside information. Much more than any increase in automatism, it is sensitivity to information on the part of machines that makes a technical ensemble possible.[17]

[10] Félix Guattari, 'Balance-Sheet for Desiring Machines', in Sylvère Lotringer (ed.), *Chaosophy* (New York: Semiotext[e], 1995a), pp. 119–150, p. 120.

[11] Erich Hörl, 'The Technological Condition', in *Parrhesia* 22 (2015), pp. 1–15.

[12] Erich Hörl, 'The Artificial Intelligence of Sense: The History of Sense and Technology After Jean-Luc Nancy (By Way of Gilbert Simondon)', in *Parrhesia* 17 (2013), pp. 11–24, here p. 12.

[13] Heinz Von Foerster, *Understanding Understanding: Essays on Cybernetics and Cognition* (University of Illinois: Springer, 2003), p. 208.

[14] Ibid., p. 208.

[15] The text was discovered after Simondon's death and written probably around 1970. Gilbert Simondon, 'Technical Mentality', in *Parrhesia* 7 (2009), pp. 17–27; reprinted in: Arne de Boever, Alex Murray, Jon Roffe, Ashley Woodward (eds.), *Gilbert Simondon: Being and Technology* (Edinburgh: Edinburgh University Press, 2012), pp. 1–15.

[16] On uncertainty and the accident in relation to technical objects and in particular to computation, see Betti Marenko, 'When Making becomes Divination: Uncertainty and Contingency in Computational Glitch-Events', in *Design Studies* 41, special issue: *Computational Making*, ed. Terry Knight and Theodora Vardoulli (London: Elsevier, 2015), pp. 110–125.

[17] Gilbert Simondon, *On the Mode of Existence of Technical Objects* (Minneapolis: Univocal, 2017).

The technological unconscious

The milieu of pervasive computing, ambient intelligence and immersive, instantaneous connectivity producing new techno-aesthetic sensibilities can be described as the *technological unconscious*. Italian artist Franco Vaccari first coined this expression in the late 1960s to signal the autonomous capacities of the machine to produce memory independent from human awareness.[18] The technological unconscious evokes an image of humans as increasingly constituted by computation, software and codes, and of electronic objects recursively and continuously reshaping the world. It evokes digital uncertainty, defined here as the potential for unprogrammed, unknown, and contingent outcomes in computation. For sociologist Nigel Thrift the technological unconscious is an immersive milieu where humans and computation feed into and adapt to each other. As computing flows in the environment filling every interstice, the technological unconscious becomes the operation of powerful and unknowable information technologies that generate 'a pre-personal substrate of guaranteed correlations, assured encounters and therefore unconsidered anticipation'.[19] These technologies produce everyday life. Today's general ecological reality, then, is made of extensively cyberneticized, heterogenic subjectivities distributed in the environment, plugged into oscillating networks of digital uncertainty and signalling a radical ontological reorganization of the human. Having addressed this fundamental transformation already in the 1980s, Guattari has been rightfully described as the 'first general ecologist and theoretician of a technological unconscious'.[20]

The non-humanity of artificial intelligence

Whether we call it Fourth Revolution, technological unconscious or planetary computation, what matters is the potential this scenario harbours for producing new concepts, new images and new narratives, and for instituting new models of knowledge creation, enquiry and future building. A key question prompted by planetary computation concerns how to envision the encounter with the non-humanity of artificial intelligence. Indeed, this encounter has no previous road-mapping and should be embraced as an entirely novel experience, moving away from the anthropocentrism that permeates current attitudes towards AI. Rather than expecting AI to be like human intelligence this opportunity should be used to experiment with notions of intelligence inclusive of what is other-than-human: distributed, extended, relational, emergent and, crucially, not necessarily carbon-based modes of thinking. After all, the most common element on earth after oxygen is silicon, a crystal found mainly in beach sand. The world of computation, the allegedly 'immaterial' world of data and hyperconnectivity, hinges on crystals of sand.[21] In a 1980 interview with Catherine Clément, Gilles Deleuze commented on this fact:

[18] Franco Vaccari, *Fotografia e Inconscio Tecnologico* (Torino: Einaudi, 2011).

[19] Nigel Thrift, *Knowing Capitalism* (London: Sage, 2005), p. 213.

[20] Hörl 2015 (footnote 11), p. 9.

[21] Betti Marenko, 'Digital Materiality, Morphogenesis and the Intelligence of the Technodigital Object', in Betti Marenko, Jamie Brassett (eds.), *Deleuze and Design* (Edinburgh: Edinburgh University Press, 2015), pp. 107–138.

> You know, it's curious, today we are witnessing the revenge of silicon. Biologists have often asked themselves why life was 'channelled' through carbon rather than silicon. But the life of modern machines, a genuine non-organic life, totally distinct from the organic life of carbon, is channelled through silicon. This is the sense in which we speak of a silicon-assemblage.[22]

Undeniably, the silicon assemblage has now become a reality. In his book on Michel Foucault, Deleuze makes further reference to the 'potential of silicon' in third-generation machines, and to the impact of cybernetics and information technologies on the formation of subjectivity.[23] The era of silicon gives tangible form to the vision of new hybrid individuals entangled with rocks and inorganic matter, gathering within him/herself both human and non-human forces (the enigmatic Superfold).

Deleuze's prescient analysis helps us to reframe human-machine interactions as an encounter with the non-human, and thus offers a way out of the anthropocentric assumption of the Turing test (in which the benchmark is human intelligence). What if, instead, we recognize the multiplicity of existing intelligences, refrain from making them like us and experiment with the unknown potential they may be heralding? Design theorist Benjamin Bratton argues eloquently against the anthropocentric fallacy that permeates the encounter with AI.[24] Rather than asking AI to pass the Turing test, this encounter should instigate different questions, so as to reimagine what counts as intelligence. Rather than fixating on something that is not there (the human-machine similarity), the focus should lie on grasping the alien intelligences that are not even recognized because they do not match human expectations. What if we paid attention to non-human forms of intelligence already existing among us? Enter the octopus.

The nonhumanity of the octopus

The octopus is an extraordinary creature **(fig. 1)**. Unique among invertebrates, it has been listed as an 'honorary vertebrate' because of its intelligence, adaptability and capacity to feel and express pain.[25] Octopuses are renowned for being smart, curious, resourceful and adventurous; they can handle tools, solve mazes, open jars and escape from impossibly tight spaces.[26] With two thirds of its neurons located in the arms rather than the brain, the octopus's neural system is exceptionally decentralized. Its arms are effectively autonomous agents. As a paradigmatic example of embodied and distributed cognition, the octopus has become a model for soft robotics and AI research.[27] This has led to the first entirely soft octobot recently developed by Harvard scientists.[28] As the closest form of alien intelligence that we can study, the octopus is the blueprint for the development of an autonomous AI whose neural networks can adapt to and learn from the environment.[29]

[22] Gilles Deleuze, 'Eight Years Later: 1980 Interview', *Two Regimes of Madness. Texts and Interviews 1975–1995* (New York: Semiotext[e], 2006), pp. 175–180, here p. 178.

[23] Gilles Deleuze, *Foucault* (Minneapolis and London: University of Minnesota Press, 1988), p. 131.

[24] Benjamin Bratton, 'Outing Artificial Intelligence: Reckoning with Turing Test', in Matteo Pasquinelli (ed.), *Alleys of Your Mind: Augmented Intelligence and its Traumas* (Luneburg: Meson Press, 2015), pp. 69–80.

[25] Peter Godfrey-Smith, *Other Minds. The Octopus and the Evolution of Intelligent Life* (London: William Collins, 2016), p. 59.

[26] Ibid., p. 64.

[27] 'Synthetic smarts. With learning robots and emotional computers, artificial intelligence becomes real', http://www.raytheon.com/news/feature/artificial_intelligence.html (accessed 25.6.2017).

[28] Leah Burrows, 'The First Autonomous, Entirely Soft Robot', in *Harvard Gazette*, 24 August 2016, http://news.harvard.edu/gazette/story/2016/08/the-first-autonomous-entirely-soft-robot/ (accessed 25.6.2017).

[29] Alfonso Íñiguez, 'The Octopus as a Model for Artificial Intelligence – A Multi-Agent Robotic Case Study', *Proceedings of the 9th International Conference on Agents and Artificial Intelligence*, 2 (2017), pp. 439–444.

Design theorist and polymath Vilém Flusser dedicated an extraordinary work of philosophical fiction to this creature. In his V*ampyroteuthis infernalis*[30] he re-configures human ontology and communicative capacities from the inhuman perspective of the giant deep-sea squid. Denouncing the one-dimensional anthropomorphic criteria by which humans understand life, Flusser deploys the non-humanity of the *Vampyroteuthis* to raise thought-provoking questions about information technology and its powers of control and capture.

> We are vertebrates of such complexity that we have managed to appropriate, by developing an immaterial art, an evolutionary strategy of mollusks. As our interest in objects began to wane, we created media that have enabled us to rape human brains, forcing them to store immaterial information. We have built chromatophores of our own-televisions, videos, and computer monitors that display synthetic images with whose help broadcasters of information can mendaciously seduce their audiences.[31]

The non-humanity of algorithms

The technological object 'algorithm' informs a radical revision of the order of things, of human rationality and of thinking itself.[32] As the epitome of the post-industrial technical object, the algorithm embodies a technicity potentially *open* to infinite re-combinations and endlessly perfectible. Andrew Goffey's formula 'Algorithm = Logic + Control' emphasizes the algorithm's programme of action: its pragmatic functioning.[33] As a statement of intent, the algorithm makes things happen; it both utters and generates. However, the conventional definition of the algorithm as recipe or 'a series of steps undertaken in order to solve a particular problem or accomplish a defined outcome'[34] is not sufficient. For media philosopher Yuk Hui the comparison algorithm = recipe fails to distinguish between an automatization of instructions (pure repetition) and an automatization through recursion, where functions are (partially) self-defined. Instead, he argues that the algorithm is modulated by a horizon of contingency, of what is neither known, nor present, yet.[35] For digital media theorist Luciana Parisi the current computational paradigm is based on the algorithm's capacity to respond and adapt to external inputs, learn rapidly and recursively base new outputs upon this learning.[36] A new dynamism intrinsic to computation emerges, a space in 'between input data and algorithmic instructions, involving a non-linear elaboration of data'[37] where 'algorithmic automation heralds the realization of a second nature, in which a purposeless and impersonal mode of thought tends to supplant the teleological finality of reason'.[38] Parisi contends that algorithmic automation, in its radical indifference to human qualities, signals the emergence of an alien, non-human mode of thinking. A case in point is the 'machine-phase' of financial markets (that is, high-frequency stock-trading) where algorithms make decisions in the order of a millisecond, faster than any human possibly could. Not only do the sub-millisecond speed

[30] Vilém Flusser (with Louis Bec), *Vampyroteuthis infernalis. A Treatise, with a Report by the Institut Scientifique de Recherche Paranaturaliste* (Minneapolis and London: University of Minnesota Press, 2012).

[31] Ibid., p. 67.

[32] On the historical lineage of algorithm as a cultural object of enchantment see: Betti Marenko, 'Filled with Wonder. The Enchanting Android from Cams to Algorithms', in Leslie Atzmon, Prasad Boradkar (eds.), *Encountering Things. Design and Theories of Things* (London: Bloomsbury Press, 2017).

[33] Andrew Goffey, 'Algorithm', in Matthew Fuller (ed.), *Software Studies: A Lexicon* (London and Cambridge Massachusetts: MIT Press, 2008) pp. 15–20.

[34] Nicholas Diakopoulos, 'Algorithmic Accountability Reporting: On the Investigation of Black Boxes', in *A Tow/Knight Brief* (New York: Columbia Journalism School, Tow Center for Digital Journalism, 2014), p. 3.

[35] Yuk Hui, 'Algorithmic Catastrophe—the Revenge of Contingency', in *Parrhesia* 23 (2015), pp. 122–143.

[36] Luciana Parisi, 'Instrumental Reason, Algorithmic Capitalism, and the Incomputable', in Matteo Pasquinelli (ed.), *Alleys of Your Mind: Augmented Intelligence and its Traumas* (Lueneburg: Meson Press, 2015), pp. 125–137.

[37] Ibid., p. 129.

[38] Ibid., p. 130.

at which algorithmic trading operates and the massive quantity of algorithm-to-algorithm interactions exceed human comprehension; neither can they be fully controlled nor their outcomes fully anticipated. In Parisi's words: 'The increasing volume of incomputable data (or randomness) within on-line, distributive, and interactive computation is now revealing that infinite, patternless data are rather central to computational processing.'[39] Drawing on mathematician Gregory Chaitin's *algorithmic randomness* – a concept according to which in every computational process the output is always greater than the input – Parisi argues that the entropic transformation of data that takes place in computation is what gives rise to the incomputable, to what she describes as the 'increasing yet unknown quan tities of data that characterize rule-based processing'.[40] The incomputable, in other words, is now at the heart of computation. This means that algorithmic automation can no longer be understood through Turing's discrete computational machine – a closed system of feedback based on a-priori instructions and endlessly repeatable step-by-step procedures (first order cybernetics). If within this older order of automation initial conditions were to be reproduced *ad infinitum*, the current mode of algorithmic automation marks a decisive break:

> It is designed to analyse and compare options, to run possible scenarios or outcomes, and to perform basic reasoning through problem-solving steps that were not contained within the machine's programmed memory. For instance, expert systems draw conclusions through search techniques, pattern matching, and web data extraction, and those complex automated systems have come to dominate our everyday culture, from global networks of mobile telephony to smart banking and air traffic control.[41]

This is the essential difference between Turing's position – where computation stops when the incomputable begins – and Parisi's, who asserts that computation is defined by its internal margin of incomputability. Incomputability, far from being a break *from* reason, signals the expansion *of* reason 'beyond its limits to involve the processing of maximally unknown parts that have no teleological finality'.[42] Remarkably, 'this challenges the view that computational processing corresponds to calculations leading to pre-programmed and already known outputs'.[43] Far from demonstrating the shortcoming of a mechanical view of computation, which equates randomness to error, the incomputable has become the absolute condition of computation, thus provoking irreversible change in algorithmic rules.

If we accept Parisi's argument, then computation becomes an incomplete affair constantly open to revision, signalling the irruption of non-human thought and demanding suitable modes of interaction. How then can the human build affinity with the non-human logic of the machine? What are the strategies to adapt to the contingent, the inventive methods to imagine new relations, the stratagems to fine-tune to the unknown? If openness, uncertainty and indeterminacy

[39] Ibid., p. 131.

[40] Ibid., p. 133.

[41] Ibid., p. 131.

[42] Ibid., p. 134.

[43] Ibid., p. 134.

characterize the new ecologies we inhabit, then we must act with astute intelligence. We must design ways of thinking from within the human-non-human ecosystems. We must develop speculations unhinged from teleology and top-down directives. We must navigate ever-shifting territories and negotiate flexible boundaries. If this is the challenge, we need tools to create new figures of thought: what I call Future-crafting.

Future-crafting

Future-crafting is concerned with re-conceptualizing contingency and rethinking uncertainty within design processes.[44] It is about treating them as material to work rather than as risks or threats to be avoided, which is symptomatic of a need to impose patterns of control and predictability. Future-crafting is the activity of giving shape to the future – here and now. *Future* is about speculating, but avoiding the trap of escaping into a fantasy of what the future could or should be. Instead, future-crafting involves ways of capturing the future and bringing it to bear on the present. This is the *crafting* part: crafting pertains exquisitely to the now. Future-crafting is speculation by design, a performative rather than descriptive strategy, whose interventions are designed to probe and problematize, provoking ambiguity and challenging the limited as much as limiting order of (anthropocentric) rationality.[45] To borrow philosopher Isabelle Stengers' words on 'speculative methodologies', Future-crafting is a practice that 'affirms the possible, that actively resists the plausible and the probable targeted by approaches that claim to be neutral'.[46] I would push this argument further, however, and argue that, more than affirming the possible, future-crafting has the propensity to actualize the virtual. There are three crucial points to consider with respect to the virtual:

· Actualization is always *problematic* and *problematizing*. Actualization is nothing but the creation of problems. This is why it is creative, because it breaks with the principle of identity, questions the existent and introduces the unforeseen.[47]

· The actual does not resemble the virtual from which it emerges. Thus the outcome of the process cannot be predicted: *unpredictability* is integral to actualization.

· Actualisation needs imagination. The creation of difference and divergence needs the *imagination* of what has not been seen before. Imagination, Deleuze writes, 'crosses domains, orders and levels, knocking down the partitions coextensive with the world, guiding our bodies and inspiring our souls, grasping the unity of mind and nature; a larval consciousness which moves endlessly from science to dream and back again'.[48]

Framed like this, future-crafting becomes a strategy and a stratagem to conjure new figures of thought. Future-crafting is a set of tools

[44] Betti Marenko, 'Incertitude, Contingence et Intuition Matérielle: un Cadre de Recherche pour un Design Mineur', in Manola Antonioli (ed.), *Biomimétisme: Science, Design et Architecture* (Paris: Éditions Loco, 2017).

[45] Alex Wilkie, Mike Michael, Matthew Plummer-Fernandez, 'Speculative method and Twitter: Bots, energy and three conceptual characters', in *Sociological Review*, 63 (2015), pp. 79–101, here p. 82.

[46] Isabelle Stengers, *Cosmopolitics I* (Minneapolis, London: University of Minnesota Press, 2010), p. 57.

[47] Betti Marenko, 'The Un-Designability of the Virtual. Design from Problem-Solving to Problem-Finding', in Gavin Sade, Gretchen Coombs, Andrew McNamara (eds.), *Undesign: Critical Practices at the Intersection of Art and Design* (London: Routledge, 2018).

[48] Gilles Deleuze, *Difference and Repetition* (London: The Athlone Press, 1994), p. 220.

at once forensic, diagnostic and divinatory. It is *forensic* because it concerns things taken as witnesses so to articulate the existent.[49] It is *diagnostic* because it invents explanatory hypotheses in an interrogative fashion – it relies on abduction, a method of investigation unconstrained by a-priori theory or a posteriori verification, but tuned to unpredictability, speculation and imagination. Drawing on cyberneticist Gregory Bateson and philosopher Charles Sanders Peirce, Parisi describes *abduction* as the process of inventing explanatory hypotheses formulated in an interrogative fashion. This is what makes abduction different from both deduction and induction: while deduction explains causal relations, induction relies on empirical facts and evidence to draw predictive hypotheses.[50]

Finally, future-crafting is *divinatory*, because it attracts images around which new thoughts can coalesce. Future-crafting gives priority to imagination over direct observation, searches for the least familiar hypotheses, those with no verifiable answer, and leans toward the production of what is not there yet. It is driven by the question *what if*? It is speculative, like sorcery, and thus resonates with similar orientations in fields like philosophy, artistic practice, design, experimental science and finance. What all these different terrains have in common is that they act in the gap between the 'could' and the 'is'. This *other* space is where Future-crafting encounters planetary computation and its urgent demands, providing us with tools to live with digital uncertainty.

Crucially, digital uncertainty draws attention to the tension between machines that are increasingly autonomous and unpredictable and the systemic control and pre-empting of expectations performed by digital apparatuses of capture. Much has been written about this: from Google's ambitious project of telling its users what they 'should be typing',[51] to the filter bubble argument according to which personalized search reinforces users' views and perspectives,[52] to the uber-connected dystopian scenario envisioned by American writer Dave Eggers in *The Circle*.[53] Planetary computation largely operates through dispositives of affective capture that, by narrowing down open-ended choices, effectively tame potential. Potential – which is always potential to actualize unknown relations and express the unexpected – is thus turned into prediction. Media theorist Anna Munster writes lucidly about this process, whereby what *might* happen next becomes what *will* happen next.[54]

This is why uncertainty is a precious resource.[55] It alters established perceptions, disrupts linear predictability and shows the potential of indeterminacy, in which the construction of what is possible depends on random, contingent and not fully known components. This, it can be argued, is the essence of creativity. Philosopher Elizabeth Grosz writes on how the production of art is linked to the chaotic emergence of the future. Grosz describes creativity as 'the capacity to elaborate an innovative and unpredictable response to stimuli, to

[49] The word 'forensics' comes from the Latin *forensis*, which means 'in public' and describes the practice of making an argument by using objects before a professional, political or legal gathering. Forensics is the creation of a forum through the investigation of objects, and is inclined towards complicated, unstable and contradictory accounts – a fuzzy forensics, rather than conclusive, objective claims.

[50] Luciana Parisi, 'Speculation. A Method for the Unattainable', in Celia Lury, Nina Wakeford (eds.), *Inventive Methods. The Happening of the Social* (Abingdon and New York: Routledge, 2012), pp. 232–244.

[51] Scott Morrison, 'Google CEO Envisions a "Serendipity Engine"', in *Wall Street Journal* (2010), https://www.wsj.com/articles/SB10001424052748703882404575520390567286252 (accessed 25.6.2017).

[52] Eli Pariser, *The Filter Bubble* (London: Penguin, 2012).

[53] Dave Eggers, *The Circle* (New York: Vintage Books, 2014).

[54] Anna Munster, *An Aesthesia of Networks. Conjunctive Experience in Art and Technology* (London, Cambridge Massachusetts: MIT Press, 2013).

[55] Betti Marenko, Phil Van Allen, 'Animistic Design: How to Reimagine Digital Interaction between the Human and the Nonhuman', in *Digital Creativity*, 27:1 (2016), special issue: Post-Anthropocentric Creativity, ed. Stanislav Roudavski, Jon McCormack, pp. 52–70.

react or, rather, simply to act, to enfold matter into itself, to transform matter and life in unpredictable ways'.[56] A similar argument is found in the science of non-linear systems, where indeterminacy is essential to the emergence and evolution of life. Physicist David Bohm sums it up neatly: 'If we were to remove all ambiguity and uncertainty, creativity would no longer be possible.'[57] If contingency and uncertainty are resources to capitalize upon, then future-crafting strategies that embrace uncertainty rather than shun it or flatten it, should be employed to experiment with scenarios of cohabitation, entanglements of the human and the non-human, and to test the creative responses emerging in the space between them. What is fostered in this space is potential, the same potential eroded by the systemic capture of planetary computation. It is on this potential that we must focus in order to craft possible futures.

[56] Elizabeth Grosz, *Chaos, Territory, Art. Deleuze and the Framing of the Earth* (New York: Columbia University Press, 2008), p. 6.

[57] David Bohm, 'Time, the implicated Order and Pre-Space', in David R. Griffin (ed.), *Physics and the Ultimate Significance of Time: Bohm, Prigogine and Process Philosophy* (Albany: State University of New York Press, 1986), pp. 177–208, here p. 198.

[58] Anthony Dunne and Fiona Raby, *Speculative Everything. Design, Fiction and Social Dreaming* (Cambridge, Massachusetts and London: The MIT Press, 2014); Alex Coles (ed.), *Design Fiction* (Berlin: Sternberg Press, 2016).

Metis

To do so we need new myths, new stories, new fictions and even new dreams that counteract the capture of the imaginary. Future-crafting steps in as a way to produce interventions that can *trouble* us, to produce fictions that create *frictions*. The feature that distinguishes future-crafting from other speculative approaches, which use design to propose critical alternatives to the existent order, resides in the specificity of its productive capacity.[58] Although future-crafting resonates with similar concerns and is likewise engaged with expanding what design can do, it puts greater emphasis on two aspects: the theoretical framework and its political valence. Acknowledging a legacy of philosophical concepts is crucial to both ground and propel forward any genuinely critical endeavor. The practice of speculating on different futures, whether to contest received notions of technology or invent new modes of human-machine interaction, is a leap into the uncertain zones at the edge of thinking. This is where the power of the imagination in seizing alternative possibilities becomes a radical tool for change and where it acquires political significance.

To live with digital uncertainty, we must develop affinity for non-human intelligence. What is needed is astute intelligence, craftiness, cunning science, the capacity to act quickly and effectively within ever-changing contexts, an intelligence that can produce localized, contingent, adaptable situated knowledges. We have it already. It is called *metis*. In Greek mythology Metis was the goddess of cunning intelligence, and Zeus's first wife. Zeus swallows her as soon as she conceives Athena, transforming her into his own body of sovereignty and control, and eliminating any unpredictability and disorder from the establishment of logos. Metis is

> a type of intelligence and thought, a way of knowing; it implies a complex but very coherent body of mental attitudes and intellectual behaviour which combine flair, wisdom, forethought, subtlety of mind, deception, resourcefulness, vigilance, opportunism,

> various skills and experience acquired over the years. It applies to situations which are shifting, disconcerting and ambiguous, which do not lend themselves to precise measurement, exact calculation or rigorous logic.[59]

If the classical human embodiment of metis is Odysseus, the Trickster, the wily agent of craftiness, multi-skills, and technical intelligence, I would like to conclude by evoking again the tentacular intelligence of the octopus: for the ancient Greeks the octopus served as the most advanced non-human embodiment of metis; most recently Donna Haraway made it a key figuration in her work on sympoetic, ecological thought.[60] In advocating the octopus as a possible image to think with, I am following the words of mid-sixth-century BCE Greek lyrical poet Theognis of Megara:

> Adopt the disposition of the octopus, crafty in its convolutions, which takes on
> The appearance of whatever rock it has dealings with.
> At one moment follow along this way, but at the next change the colour of your skin:
> You can be sure that cleverness proves better than inflexibility.[61]

[59] Marcel Detienne, Jean-Pierre Vernant, *Cunning Intelligence in Greek Culture and Society* (Hassocks: Harvester Press, 1978), p. 3.

[60] Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham: Duke University Press, 2016).

[61] From the Theognidea (lines 213–218), Andrew M. Miller (trans.), *Greek Lyric: An Anthology in Translation* (Indianapolis: Hackett, 1996).