

## Environments (out) of Control: Notes on Architecture's Cybernetic Entanglements

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Gaia is not a cybernetic machine controlled by feedback loops but a series of historical events, each of which extends itself a little further – or not.

Bruno Latour, 2017<sup>1</sup>

Autopoietic systems are hugely interesting – witness the history of cybernetics and information sciences; but they are not good models for living and dying worlds and their critters ... Poiesis is symchthonic, sympoietic, always partnered all the way down, with no starting and subsequently interacting 'units'.

Donna J. Haraway, 2016<sup>2</sup>

Will the recursive thinking in cybernetics allow us to relaunch the question of organicism and technodiversity, or will it, being driven by efficiency for the final cause imposed by capital, finally only realize a purely deterministic complex system that is moving toward its own destruction?

Yuk Hui, 2019<sup>3</sup>

In her recent book *In Catastrophic Times*, philosopher Isabelle Stengers evokes a powerful image to describe our contemporary environmental condition: 'the intrusion of Gaia'.<sup>4</sup> By summoning this figure, Stengers alludes not only to the mythological goddess of antiquity but especially to her modern incarnation in the cybernetic, self-regulating complex system theorised by chemist James Lovelock and microbiologist Lynn Margulis in the 1970s, which became a popular rallying metaphor for the environmental movement. For Stengers, Gaia constitutes neither the earth as a concrete

object nor a metaphor for provoking a sense of belonging; rather, to name Gaia is to recognise the intrusion of a form of transcendence into our history – an assemblage of material processes that are indifferent to humans, yet whose slightest movements threaten the survival of our civilisation today.<sup>5</sup> The question of how to 'come to terms, or compose with Gaia' thus becomes the problem of the so-called Anthropocene epoch.<sup>6</sup> More than a new geological era, the Anthropocene signals a non-negotiable end to the deeply entrenched division between nature and culture that had served as the ontological basis of modernity.<sup>7</sup> The shift manifests in a reconceptualisation of ecology, from a restrictive image of 'nature' to a generalised notion of techno-ecology.<sup>8</sup> This transformation has been described as 'environmentalisation', the becoming-environmental of all aspects of life – including power, knowledge, subjectivity, media and thinking.<sup>9</sup>

Margulis and Lovelock's Gaia is a circuitous product of the transdisciplinary field of cybernetics. Post-war cyberneticisation has propelled a profound reconceptualisation of how the world is composed and, in turn, how it can be engaged, organised and governed. Manifold entities – from the smallest of organisms to large-scale networks – have come to be viewed as complex, self-organising and self-making (autopoietic) systems, coupled with their environments through feedback and crisscrossed by information. Historian of science Andrew Pickering describes the 'non-modern ontology' of cybernetics according to three trajectories that mark a departure from modernity: (1) the centrality of agency and

performance, as opposed to intention and knowledge; (2) the prevalence of emergence, as opposed to linear causality; and (3) the decentering of the human as a source of explanation and control, acting amid a multiplicity of entities.<sup>10</sup> While cybernetics dissipated as a unified, identifiable field by the end of the 1970s, it continues to exert a profound, if often invisible, influence. Today, cybernetic circuits comprise the underlying logic of the contemporary global economy: an environmental form of communication and control. These transformations have in turn crystallised in a new environmentality across the field of design, concerning not only the way buildings, landscapes or cities are conceived but also practices of production and inhabitation.

Contemporary architectural discourse on cybernetics appears to be split along a series of contradictions, most notably between optimistic calls for its deployment as an ethos of conversation and choice and critical accounts of its invisible environmental-behavioural hegemony. Cybernetics in these debates is seen variously as a comprehensive theory of (self-)regulation, complexity, and information exchange, yet also as an obscure scientific field with very few designers possessing in-depth knowledge of its concepts and methods. It is thought to have been forgotten and in need of 'rediscovery', yet its assumptions are detected across commonplace operations in contemporary design. It is seen to hold untapped potential as a liberating mechanism for choreographing emergence, adaptation and open-endedness, but conversely, as an anti-democratic obscuring of power through environmentally modulated forms of control.

Given the profound spatial implications of the paradigm shift outlined above, an examination of contemporary architecture's cybernetic entanglements is fundamental for a critical reevaluation of environmentality in the discipline. In this article we map the cybernetic imaginary 'at large' across the design fields under various guises, including but not limited to adaptation, resilience, responsiveness, smartness, various metaphors of cultivation and

conversation, as well as variations on -management. We examine these attitudes in the context of the development trajectory of environmentalisation and the critical discourse emerging around the history of cybernetic projects in order to probe their problematic proximity to the environmental control logics of cybernetic capitalism, with the intent to question and move beyond them.<sup>11</sup> The task, then, is to re-position cybernetics, opening up new critical-speculative horizons amid and beyond its restrictive circuits. We present two such trajectories in the final section of the article, grounded in affirmative contingency and sympoietic response-ability.

### **Architecture's environmentality**

Whether or not the term is mobilised as an explicit qualifier, a cybernetically-charged environmentality abounds in architecture and allied fields today – at times as mere metaphors or aspirations; in other cases as tangible strategies of design practice. Buzzwords such as 'adaptation', 'responsiveness', 'resilience' and 'openness' signal increased attentiveness to organisational complexity, temporal evolution, and agential plurality. Not unlike the 'general good' associated with so-called ecological or sustainable practices, the positive undertones of these approaches tend to render them opaque, albeit not immune, to critical probing. Yet scrutiny is warranted, particularly concerning the ways these tendencies in design conceive of and seek to condition organisms and their environments.

Extending Pickering's conceptualisation of cybernetic ontology, three tendencies of cybernetic influence on architecture are particularly notable: the shift from direct to indirect modes of control; from a focus on static objects to temporal processes and evolution; and from geometrical to topological operations. Firstly, in place of modernist convictions of the complete knowability of the world, the subsequent cybernetic view of irreducible complexity and indeterminacy has prompted a shift from direct, top-down modes of ordering form, to indirect, system-wide approaches of instigating formation,

or in Gilbert Simondon and Gilles Deleuze's memorable formulation, from an enclosure-based moulding to an environmental modulation.<sup>12</sup> In this latter modality, the designer is seen operating on a substrate, scripting protocols rather than dictating form: 'the architect is a system designer who cultivates, rather than designs, a system'.<sup>13</sup>

The modulatory attitude was already articulated in the cybernetic architectural theories of the post-war decades, such as Gordon Pask's notion of design as a 'control of control', or Sean Wellesley-Miller's call for the designer to 'stimulate, steer, and stabilize the process' of self-organisation.<sup>14</sup> These views find their parallels in the present-day 'cultivation mentality', centred on catalysing system-wide transformations and manifest in the many ecological-agricultural metaphors, from seeding to propagation, from cultivation to more than two decades of discourse on fields, from the 'irrigation of territories with potential' to calls to 'alter the soil, not square off against every weed'.<sup>15</sup> They also pervade the many 'urbanisms' of late, such as landscape-, infrastructural-, ecological urbanism, and various agency-valourising practices such as 'critical spatial praxis' or the explicitly cybernetic notion of conversation as a design methodology.<sup>16</sup> In all of these formulations, the shift away from centralised control is seen as liberatory, opening up the field of design to the complexity of interactions across a plurality of more-than-human agents. The design process adopts the form of a 'choreography', a guided evolution in which 'an overemphasis on control and efficiency gives way to dynamic and open-ended linkages between people's intentions for the landscape and the non-anthropogenic forces at work'.<sup>17</sup>

Closely following from this point is the shift in focus from designed objects to evolution and change – the temporal management of transformations. Systems are seen not only as complex but also dynamic, necessitating the anticipation of change over time and ongoing response to it. This attitude can be most clearly seen through the discursive pervasiveness of variations on

adaptation, resilience, and responsiveness. Contrary to modernist pursuits of flexibility, adaptation is deployed in explicitly ecological terms across a range of territories and scales, from computational design to landscape infrastructural projects. Adaptation in these contexts is used in the sense of adaptive systems, characterised by biologists and cyberneticists as 'organisms or mechanisms capable of optimising their operations by adjusting to changing conditions through feedback'.<sup>18</sup>

Finally, indirect modulation and temporal management coincide with a shift of emphasis from geometric/topographic to relational/topological operations. What comes to matter in conceptualising design interventions is less the shaping of geometric figures at particular scales than the manipulation of contingent relations across scales. This notion informs for instance the 'diagrammatic' approach formulated around the turn of the millennium and all-pervasive across the discipline today. As a topological figure, 'the diagram focuses on the organisational, privileging relations and their organisation over anything else. The diagram defines relations within the system, protocols rather than a plan in the traditional architectural sense'.<sup>19</sup> Topological modulations are also seen in contemporary approaches to material computation, which adapt a particular eco-logical conception of nature, involving 'not an (associationist) interaction of parts, but the capacities of the environment, defined in terms of a multiplicity of interlayered milieus or localities, to become generative of emergent forms and patterns'.<sup>20</sup> Notably, such topological and a-scalar/multi-scalar operations in or on complex and dynamic environments often depend on intensive digital technologies during the design and implementation process, such as 'time-based programming, environmental modelling, and real-time visualization'.<sup>21</sup> These processes thus provide a profoundly techno-ecological framing for architecture.

These cybernetic attitudes – concerning both the nature of reality and the corresponding disposition

of design intervention – have over more than two decades consolidated around a constellation of idioms that together comprise the cybernetically charged ‘environ-mental lexicon’ of contemporary architecture. [Fig. 1] At large across discourse and practice, these approaches embody a broader, paradigmatic shift from modernist to environmentalised conceptions of organisation and control – a notion explored in the following section.

### Cybernetic state of nature

Although contemporary architecture has been lost in a field of environmental operations – ecological design, green building, sustainable urbanism, and more – there has been limited critical scholarship from within architecture history and theory that contextualises these environ-mentalities in all their material-semiotic, technological, historical and onto-epistemological dimensions. The necessity of such analysis is demonstrated by the recent work of philosopher and cultural theorist Erich Hörl. At the heart of Hörl’s inquiry is an examination of the interrelationships between the epochal tendency of environmentalisation, its manifestation as a particular environmental mode of governmentality (Environmentality), and the techno-ecological underpinnings of both in the form of a ‘cybernetic state of nature’.<sup>22</sup> Hörl characterises our contemporary condition as a new historical semantics of environmentalisation, the becoming-ecological of the world:

There are thousands of ecologies today: ecologies of sensation, perception, cognition, desire, attention, power, values, information, participation, media, the mind, relations, practices, behavior, belonging, the social, the political – to name only a selection of possible examples. There seems to be hardly any area that cannot be considered the object of an ecology and thus open to an ecological reformulation.<sup>23</sup>

Environmentalisation thus constitutes an epochal shift from an immunopolitical conception of ecology

– based on the division of technology and nature, where the latter is conceived as an other to the teleological rationality of technicity – to a denaturalised, non-anthropocentric techno-ecological condition characterised by the end of modern rationality and purpose; in other words, a (re)turn to a non-modernity.<sup>24</sup>

Far from being an inherently liberating development, however, environmentalisation has also resulted in the restricted form of Environmentality.<sup>25</sup> This term was first used by Michel Foucault in the late 1970s to describe the then-emerging form of governmentality seen fully formed today. Foucault noted a shift from the normalising, disciplinary power strategies of moulding to ‘an entirely different form of intervention, a kind of non-intervention in the form of modulation’, an environmentally distributed mode of control.<sup>26</sup> Hörl extends Foucault’s analysis of power to also incorporate the becoming-ecological of subjectivity, knowledge, technology, media, and crucially, of capital.<sup>27</sup> He refers to this comprehensive formal analysis of environmentality as general ecology, ‘a thinking of becoming-environmental’.<sup>28</sup>

The necessity of introducing this general ecological analysis in the field of design has been demonstrated by architectural historian Daniel Barber, who extends Foucault’s inquiry into environmentalised governmentality, applying it to the historiography of twentieth-century architecture. Following Sven-Olov Wallenstein, Barber argues that modern architecture ‘emerges as “an essential part of the biopolitical machine” ... [and] comes to embody and enforce the process of governmentalisation’.<sup>29</sup> In this analysis, the environment (*milieu*) comprises a biopolitical and techno-ecological enframing whose existence precedes, and thus shapes, architectural operations.<sup>30</sup>

Hörl identifies the process of cyberneticisation over the course of the twentieth century precisely as the underlying techno-ecological frame of environmentalisation and environmentalitarian governmentality:

The technological evolution that drives this fundamental re-ecologization of thinking and of theory as well as the readjustment of the apparatus of capture [has unfolded] since the end of the nineteenth century and especially since 1950 in an ongoing process of cyberneticisation, in *an environmental culture of control that is radically distributed and distributive*, manifest in computers migrating into the environment, in algorithmic and sensorial environments.<sup>31</sup>

Cybernetics therefore figures simultaneously as an initial catalyst and subsequent symptom of general ecologisation. Its modulatory mechanisms of regulation and control are both entangled with the formation of the contemporary ecological imaginary and the development of non-modern forms of rationality, yet they are also crucial to the operation of the techno-capitalist power-form of Environmentality.

It is thus instructive to briefly rehearse the post-war genealogy of cybernetics, in order to both draw out some of its historical contingencies, and examine its figuration in architectural theorisations of the environment. [Fig. 2] Three parallel genealogies are crucial: (1) the 'internal' story of the evolution of cybernetics, often rehearsed without taking account of its technological dependencies; (2) a cultural-historical reading that positions cybernetics as a catalyst for the contemporary posthuman condition and has served as a point of reference for architectural historiography; (3) and a techno-ecological trajectory, which allows to draw closer links between architecture's environmental idioms and the control logics of Environmentality.

The theoretical field of cybernetics – sometimes regarded as a subset of systems science – distinguishes two stages in its development: first- and second-order cybernetics, respectively described as the science of observed systems and observing systems. Whereas the technological path-dependency of cyberneticisation often remains obscured in this periodisation, literary critic N. Katherine Hayles has thoroughly examined the historically contingent evolution of cybernetics, with a focus on the

disembodied conception of information.<sup>32</sup> Through a meticulous cultural historiography, Hayles identifies a series of overlapping conceptual constellations, each operative in relation to particular material-technological artefacts: homeostasis (1945–60), autopoiesis (1960–85), virtuality (1985–95), and most recently, the regime of computation (1995–present).<sup>33</sup> This periodisation both reveals the way cybernetics propelled the deconstruction and replacement of the liberal humanist subject with the particular posthuman figure of the cyborg (short for cybernetic organism), and contests the inevitability of the separation of information from materiality:

The adaptation of a disembodied view of information spread so pervasively ... because it fitted well with existing preconceptions about a separation between a material body and an immaterial essence, which of course was a subtext for a disembodied view of information in the first place.<sup>34</sup>

The outcome of this preconception, according to Hayles, is a two-part process of abstraction of reality, by first reducing the infinite multiplicity of the real to a simplified model and subsequently simulating a 'multiplicity sufficiently complex that it can be seen as a world of its own'.<sup>35</sup>

Architect Ariane Lourie Harrison adopts Hayles's historiography in her introduction to *Architectural Theories of the Environment: Posthuman Territory*, focusing the architectural discussion of cybernetics around the cyborg, most famously theorised by Donna Haraway as a networked organism that resists binary conceptualisations such as human-animal or human-machine.<sup>36</sup> Posthuman theory, Harrison argues, 'extends the cyborg metaphor beyond the body and into the built environment, imagining designed space itself as a prosthetic and producing new understandings of a "nature" that itself can no longer be conceived as an originary or neutral ground'.<sup>37</sup> The limitation of this framing – in addition to its characteristic misreading of the cyborg as a 'hybrid' – is the conceptual prioritisation

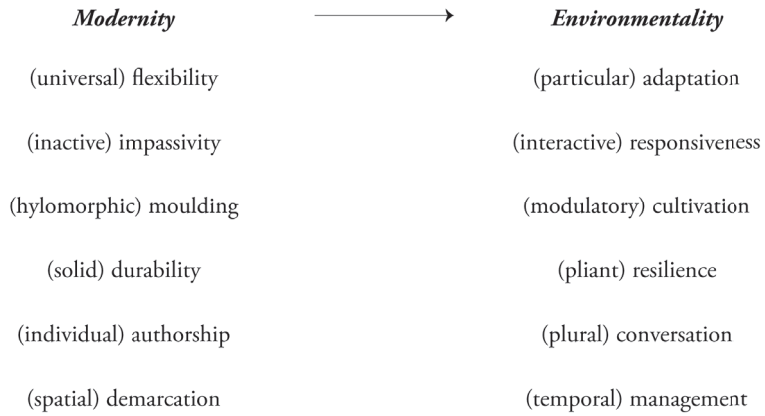


Fig. 1

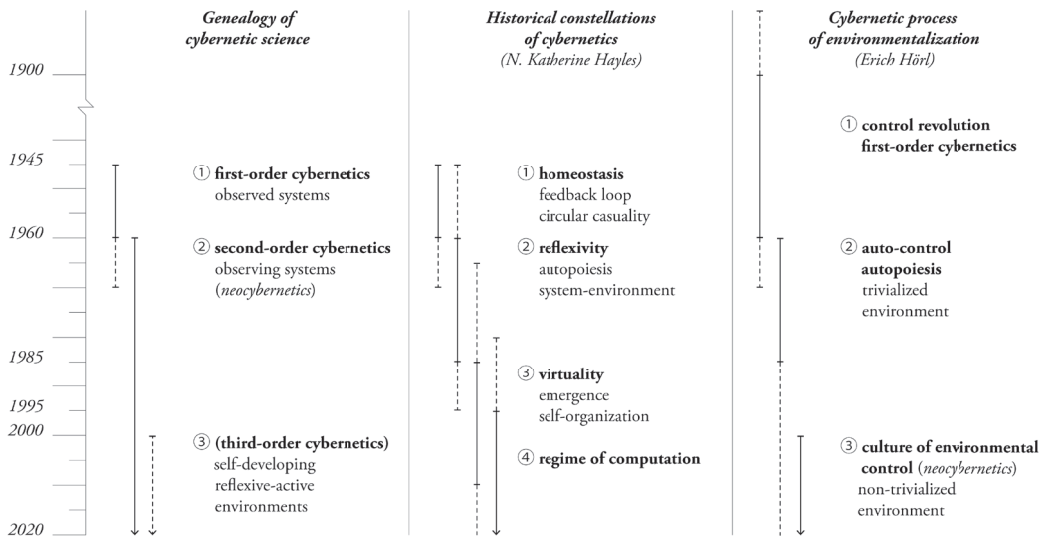


Fig. 2

Fig. 1: Architectural idioms of modernity and environmentality. Diagram: authors.

Fig. 2: Historical trajectories of cyberneticisation. Diagram: authors.

<i>Time period</i>	<i>Governance strategy</i>	<i>Underlying ontology</i>	<i>Operating principle</i>	<i>Operating logic</i>	<i>Environmental logic</i>	<i>Spatial manifestation</i>
20th c.	Modernity	rationality	linear causality	progress	<b>moulding</b> (discipline)	hylomorphism masterplanning
	Mapping	autopoiesis	non-linear causality	adaptation	<b>cybernetic modulation</b> (control)	parametric/material computation ecological/infrastructural urbanism
21st c.	Sensing	homeostasis	correlation	responsiveness		responsive architecture smart city
	Hacking	sympoiesis	experimentation	radical openness deterritorialization	<b>collective production</b> (contingency)	architectures of response-ability & contingency

Fig. 3

Fig. 3: Ontopolitics and cybernetic logics. Diagram: authors. Adapted from David Chandler, *Ontopolitics in the Anthropocene: An Introduction to Mapping, Sensing and Hacking* (Abingdon, Oxon: Routledge, 2018), 23.

of the posthuman body. Making it the primary point of reference pre-empts the possibility of detecting any underlying connections between the cybernetic logics of architectural interventions and the already-cyberneticised environments in or on which they operate, thus missing the more fundamental link to the techno-ecological enframings emphasised by both Hörl and Barber.

Hörl's genealogy of cybernetics thus becomes particularly pertinent by situating it within the broader arc of technological development that has given rise to environmentalisation. This longer history of control begins in around the mid-nineteenth century and includes nebulous developments in routinisation, bureaucratisation, technical tinkering, engineering and management, as well as the instrumentalisation of control in first-order cybernetics, centred on adaptive behaviour and the feedback loop.<sup>38</sup> The second phase commences in the late 1960s to early 1970s with second-order cybernetics and concerns manipulative behaviour, auto-control and autopoiesis. Whereas both of these periods conceive the environment as a trivialised surrounding, the current, third phase – which Hörl somewhat confusingly terms 'neocybernetics' – marks 'the emergence of an environmental culture of control' based on the environmental distribution of agency by media technologies:<sup>39</sup>

It is only with this phase that environmentality in the widest sense becomes problematic and takes the form of a new problematics of Environmentality as our mode of governmentality; its main problem is the capture and the control, the management, the modulation of behavior, of affects, of relations, of intensities, and of forces by means of environmental (media) technologies whose scope ultimately borders on the cosmic ... Cyberneticisation crystallizes as Environmentalisation.<sup>40</sup>

An all-pervasiveness of environmentalised forms of control, then, constitutes the contemporary 'neocybernetic regime of truth', or as the Tiqqun collective

puts it, 'the cybernetic hypothesis'.<sup>41</sup> To recap: the post-war process of cyberneticisation, as part of the broader trajectory of the 'control revolution', has been a key catalyst for environmentalisation. It thereby propelled both the expansion of ecology from a restrictive sense of nature to a generalised techno-ecological paradigm, and the proliferation of techno-ecological modes of regulation and control across all aspects of life under the regime of environmentalitarian governmentality. These transformations, which are only accelerating due to recent technological developments, have not been sufficiently examined in architectural history and theory. Such critical inquiry through the dual lens of e/Environmentality is particularly warranted, given the proliferation of cybernetically inclined idioms and approaches across contemporary architecture, landscape and urbanism.

### **Cybernetic ontopolitics**

Political scientist David Chandler's theorisation of contemporary governance strategies, most comprehensively outlined in *Ontopolitics in the Anthropocene*, offers a valuable framework for contextualising and critiquing the constellation of environmental idioms in design as approaches in relation to environmentalitarian governmentality. Defining ontopolitics as 'a new set of grounding ontological claims that form the basis of discussions about what it means to know, to govern and to be a human subject', Chandler argues that the Anthropocene epoch 'appears to bring to a close the human-centred, subject-centred or anthropocentric understandings of power and governmental agency'.<sup>43</sup> With the end of modernist assumptions of progress, universal knowledge and linear causality, contemporary ontopolitical strategies – introduced as 'mapping', 'sensing' and 'hacking' – seek to 'adapt or respond to the world rather than seeking to control or direct it'.<sup>44</sup> Crucially for this discussion, Chandler characterises both mapping and sensing with reference to cybernetic logics. [Fig. 3] This ontopolitical lens thus both substantiates and



supplements Hörl's analysis of Environmentalism, and allows for resituating the sporadic commentaries on cybernetic approaches in architecture and urbanism within this broader framework.

Firstly, the ontopolitical approach of mapping arises from a refutation of the linear causality of modernism, assuming instead the non-linear logic of autopoiesis (self-production). Chandler traces the logic of mapping to the post-war rejection of the universalist assumptions of knowledge and the possibility of top-down governance, and the resultant shift towards the notion of bottom-up agential choice-making in response to historical, social, and economic contingencies.<sup>45</sup> Thus, mapping approaches, grounded in bottom-up immanence

inform a wide-range of governing practices and philosophical perspectives, from neo-institutionalist understandings of contingency, context and path-dependencies, to the adaptive cycles and panarchies of ecosystem resilience and the more radical conceptions of assemblage theorists, seeking to map and to understand nested assemblages of non-linear causal chains of emergence.<sup>46</sup>

As should be clear from the preceding discussion, the adaptive modulations that characterise mapping can be seen at work in ecological and infrastructural urbanism, resilience approaches in landscape architecture, as well as in much of computational design. Notably, the ontological richness of mapping – its recognition of the plurality, flux, and difference of the world – quickly becomes a difficulty in actual governance, insofar as the interplay between equilibrium and emergence requires constant modulation: 'what starts out as a "light touch" or indirect recursive process of "designing for design" appears to end up requiring a much more interventionist process of regulation and monitoring than that assumed by "top-down" "command-and-control"'.<sup>47</sup>

Indeed, a central criticism mounted against cybernetics in architecture and urbanism concerns the obfuscation of control, power and politics in

decentralised systems. Control, as elaborated by media theorists Alexander Galloway and Eugene Thacker, is not a disciplinary form of power over someone or something, but as a ground that in turn conditions interaction: 'one does not simply control a device, a situation, or a group of people; rather, "control" is what enables a relation to a device, a situation, or a group'.<sup>48</sup> In this reading, decentralised systems are hardly free of control; rather, control becomes distributed across the system and thus more difficult to detect and contest. Cybernetics has a propensity 'to render power relations invisible, power is no longer anywhere special, but this does not mean it is absent, only that it is in the *framing* of the system rather than the active enforcement of discipline within the system'.<sup>49</sup> With the architect commonly conceived as a systems designer who authors not form but 'the parameters or protocols according to which the system evolves', their role increasingly becomes that of a cybernetic programmer of environmental power.<sup>50</sup>

A pivotal reference for this discussion is the 'cybernetic hypothesis' of Tiqqun, who argue that far from having disappeared, cybernetic notions about conceiving, modulating and predicting biological, physical and social behaviour serve as an ideological backdrop to contemporary neoliberalism, which thus constitutes cybernetic capitalism.<sup>51</sup> In a similar manner, theorist Douglas Spencer traces the shared ideological origins of neoliberal economic thought and contemporary post-critical architectural practices – in both cases originating in post-war cybernetics and systems theory.<sup>52</sup> He notes that the cybernetic notion of the environment, such as 'its transcategorical forms of knowledge, its entrepreneurial orientations, its celebrations of networked mobility and its promises of self-transcending immersion', were quickly embraced by the counterculture movement as a liberatory mechanism against instrumental reason, and also came to inform architectural discourse during the 1960 and 1970s. These perspectives became fully normalised by the 1990s, and served as an ideological

foundation for the rise of post-critical attitudes around the turn of the millennium.<sup>53</sup> Following a similar thread, architect Fredrick Torisson detects the cybernetic hypothesis at work not only in neoliberally-aligned post-critical approaches to architecture that arose in the late 1990s, but also in more recent counter-movements such as 'critical spatial praxis'. He argues that even this latter, distributed-agency-valorising mode of practice falls short of understanding the extent of the architect's modulatory power. The result of such obscuration of power is the risk of the collapse of politics onto the framing (modulation) of the system – in other words, a 'cybernetic politics'.<sup>54</sup>

In contrast to this attempt to grasp and manipulate non-linear causal relationships, Chandler characterises the ontopolitical strategy of sensing as operating based on correlation and according to the first-order cybernetics of homeostasis. Instead of pursuing non-linear causality, sensing strategies deploy responsive modulations of surface effects in order to maintain the status quo.<sup>55</sup> While its underlying cybernetic logic historically predates that of mapping, sensing as an environmental governance strategy could fully emerge only with the development of algorithmic computation and big data. Notably, whereas through these intensive technologies it appears to constitute a 'real time' responsiveness,

sensing does not seek to make causal claims, the emergence of effects can be traced to reveal new relations of interaction and new agencies or actants to be taken into account but there is no assumption that effects can be understood and manipulated or governed through transcendental policy goals – real time responsive forms of management through Sensing increasingly focus on the 'what is' of the world in its complex and plural emergence.<sup>56</sup>

However, Chandler also notes that 'real time' is a mere illusion created by the speed at which technologies operate. Rather, responsiveness holds time

constant, in a manner of the control society outlined by Deleuze nearly three decades ago: 'instead of a before (prevention) or an after (reaction) there is the continual modulation of responsiveness, an "endless postponement" of a problem'.<sup>57</sup> In a similar vein, sociologist Orit Halpern describes cybernetic rationality through Brian Massumi's notion of preemption. In contrast to prevention, based on an empirical assessment of threats and their causes, preemption is 'affective; it lacks representation; it is a constant nervous anticipation ... for a never fully articulated threat or future'.<sup>58</sup> As Halpern further remarks, this cybernetic rationality replaces the incalculable difference of infinity with a 'dream of self-organizing systems and autopoietic intelligences produced from the minute actions of small, stupid, logic gates, a dream of a world of networks without limit, focused eternally on an indefinite and extendable future state'.<sup>59</sup>

This preemptive logic can be seen at work in the environmentally-mediatised paradigm of the smart city, as well as in the responsive digital technologies increasingly populating and defining our domestic architectures, thus 'intensifying the discourse of responsivity from the sphere of the market to the governance of life as a whole'.<sup>60</sup> Urbanist and historian Maroš Krivý examines the smart city through a cybernetic lens, arguing that it is characterised by 'environmental-behavioural control' under which the 'the subject citizen is at once an infra-individual profile of desires, attitudes and preferences and a vector within their supra-individual articulation as a "swarm."<sup>61</sup> Operating on the principles of data-behaviourism and preemptive nudging whose interactive circuits of feedback foreclose genuine social change, for Krivý the smart city engenders the simultaneous collapse of the concept of the urban and of urban politics.<sup>62</sup>

Another prominent instance of the preemptive operation of sensing is found in the digital tools and technologies employed by designers, which in and of themselves operate according to the cybernetic temporality of real time. Unlike historical time that, as

architect John May comments, 'was concerned with representing the past as a way of *determining the future*, real time presents all possible futures at once (or at least as many as can be counted, computed, and parametricised) as a way of *managing the present*'.<sup>63</sup> The substrate of this temporality, the managerial surface, comprises a 'silent epistemological backdrop' for design practice today.<sup>64</sup> Its electronic expanse collapses the political and metaphysical dimensions of the real into a digitised, statistical, scale-less and automated abstraction of reality, recasting the activity of designers as environmental management.<sup>65</sup> As May further suggests, the telematic images thereby produced 'silently posit an entire cosmological theory of life in every scene (in general, that the world is a statistical object and is therefore best understood as an ever-growing body of electrical data)'.<sup>66</sup> Thus, as Chandler aptly remarks, as a result of the displacement of causality with the modulation of effects through responsiveness under the sensing paradigm, the modernist notion of politics is fully inverted: 'politics becomes based upon the subject responding to and being sensitive to the world and its environment, rather than acting to change it'.<sup>67</sup>

An important insight of Chandler's analysis – drawing on the work of the cultural theorist Claire Colebrook – is that despite their epistemological break with modernist notions of universal knowledge and top-down control, adaptive mapping and responsive sensing paradoxically reinforce instrumental reason:

Mapping and Sensing are no less anthropocentric than the transcendental problem-solving of modernist promises of progress. As long as modes of governance view the Anthropocene condition as a problem to be *mitigated, adapted to, managed, controlled or 'solved'* in some way, then the end of the modernist assumptions about the world is constituted as a problem to be faced in the future rather than our present condition.<sup>68</sup>

Therefore, these adaptive and responsive

ontopolitical strategies, embraced as progressive alternatives to modernist notions of regulation and control, at their worst constitute the very operating logics of today's cybernetic capitalism, of Environmentality. A similar observation is made by theorist Luigi Pellizzoni, who argues that recent philosophical affirmations of 'indeterminacy' and 'constant becoming' miss or downplay 'the politics of ontology inbuilt in the neoliberalisation of nature, which builds precisely on these tenets'.<sup>69</sup> Also caught up in these eco-logical circuits are the many cybernetically charged strategies of adaptation, responsiveness, resilience and cultivation across architecture, landscape and urbanism, warranting historicisation and critical scrutiny.

Indeed, many observers of the cybernetic hypothesis in architecture and urbanism tend to voice a call for a return to critique – manifesting in a negativity, withdrawal or refusal. Others, however, would contend that such a characteristically modernist notion of critique has become untenable as a result of the onto-epistemological transformations of the Anthropocene epoch, necessitating a transvaluation of critique into affirmative, constructive forms.<sup>70</sup> A middle ground, or rather, a two-pronged approach is offered by Hörl's aforementioned proposal for a general ecology. On one hand, general ecology comprises an in-depth examination and critique of restrictive environmentalitarian forms. On the other, it is also a reevaluation of environmentality as a driving force of a 'radically relational onto-epistemological renewal'.<sup>71</sup> Instead of trying to negate our cybernetic entanglements, there are perhaps ways of affirming and concomitantly reshaping matters. Cybernetics, as Halpern notes,

permits dangerous proximities and alternative recombinations within space while posing simultaneous threats of homogenisation; the trick is to vacillate between the immediate and the deferred, to reject the laws of the binary order that ignore what cybernetics first brought into the world, which is the decentering of

our egos, and to develop the ability to recognise that our consciousness and subjectivities are in lag to the world and are comprised through our interactions with others.<sup>72</sup>

Thus, exposing the historic closures and conceptual shortcomings of our cybernetic state of nature can in turn allow for critical-speculative work that moves along ‘a possible opening of neocybernetic power’ – as we will explore in the final section.<sup>73</sup>

### Environments beyond control

Rather than passively appropriating the restricted logics of the contemporary ‘cybernetic state of nature’, the task at hand is to conceive and affirm alternative worldings. The following two trajectories, centred on the recent work of philosophers Yuk Hui and Donna Haraway, exceed the restrictive circuits of adaptive and responsive modulation, speculating on new cosmopolitics.<sup>74</sup> Haraway and Hui interrogate and expand the foundations of cybernetic environmentality, affirming the contingent and entangled nature of becoming, and in doing so, gesture towards material practices beyond environmentalitarian circuits of control.

In *Recursivity and Contingency*, Yuk Hui charts an alternative trajectory of cybernetics within organology, a philosophical tradition centred on technology, proposing a cosmopolitics grounded in a reevaluation of fortuity against the predictive-reductionist logic of Environmentality. In Hui’s analysis, ‘cybernetics proper’ is part of the tradition of organicism, the post-Kantian philosophy of nature.<sup>75</sup> It constitutes, in its first- and second-order iterations, the culmination of the organicist synthesis between mechanistic (Newtonian) and vitalist (Bergsonian) conceptions of nature. In other words, ‘organization through cybernetic thinking has realised (in a certain sense) the general organism *qua* cybernetic system, which is called *ecology*’.<sup>76</sup> This ecological-organicist trajectory stands in contrast to organology, most notably theorised by Gilbert Simondon and Bernard Stiegler, whose inquiry Hui extends.

Both cybernetics proper and Simondon’s universal cybernetics conceive of reality as recursive, but they differ in the role played by contingency, the unexpected.<sup>77</sup> This divergence manifests most fundamentally in the concept of information. On one hand, cybernetic information is conceived as non-physical and probabilistic.<sup>78</sup> A cybernetic system is thereby characterised by a ‘nonlinear movement with predefined finality’ in which contingency, such as noise, is absorbed by the system by ‘turning it into something probable – that is to say, that which is expected’.<sup>79</sup> While Simondon does not reject outright this probabilistic, quantifiable notion, he deems it secondary to his ontogenetic conception of being, insofar as it presupposes an already constituted individual.<sup>80</sup> Instead, Simondon understands information more broadly as a signification that produces a change in the operation of a system: ‘information is not a thing, but the operation of a thing arriving in a system and producing in it a transformation’.<sup>81</sup> This operation, termed individuation, constitutes a ‘nonlinear movement with auto-finality’, a movement without a predefined goal that proceeds according to contingent events.<sup>82</sup> It is an ongoing, ever-incomplete process of coming into being in relation to one’s environment, which is simultaneously psychic and collective – a transindividual relation.<sup>83</sup> While individuation ‘necessarily involves relations between multiple orders of magnitude ... it is not necessarily defined by a teleological end, but rather it moves towards an undetermined end driven by the tendency to resolve tensions and incompatibilities’.<sup>84</sup>

Deleuze, in many of his writings, deploys a concept of modulation that appears largely analogous to Simondon’s notion of individuation as the modulated process of becoming. Yet in ‘Postscript on the Societies of Control’, he uses the term in a more restricted, critical sense to describe algorithmically-inflicted forms of self-regulation that ‘recursively modulate the social relations with precisely defined orders of magnitude and attempt to move the system toward ever-greater efficiency’.<sup>85</sup> As Hui explains,

these divergent semantics – one synonymous with hyper-control in contemporary capitalism, the other with a new conception of becoming – are reflected in the two images of cybernetics:

one is reductionist; it reduces organisms to feedback systems, which are imitations; it imposes determinism, since all reductions aim for prediction, all predictions are determinisms; its economy is an economy of finality. The other is non-reductionist, in the sense of Simondon's general allagmatic, which seeks genesis beyond any form of technological determinism; it is open to contingency without only reducing it to calculation and endorses auto-finality.<sup>86</sup>

Rather than rejecting cybernetics outright as an environmentalitarian operation of disindividuation, Hui argues that the contemporary task is to 'conceive a new perspective ... by undermining the tendency of its totalizing and deterministic thinking' and experimenting with new forms of modulation and individuation.<sup>87</sup> Following Simondon as well as Deleuze, this begins with the affirmation of 'the fortuitous nature of existence': instead of bringing contingency under control through preemption, affirming difference as chance.<sup>88</sup>

A radically (counter-)modulatory approach in architecture and other fields of environmental design, then, warrants a critical reevaluation of the binary logics underlying the media in and through which designers operate. This, in turn, would allow for an unorthodox mobilisation of material-semiotic media towards discovering 'extra political and aesthetic capacities in indeterminacy, discrepancy, temperament and latency', as architect Keller Easterling puts it.<sup>89</sup>

In *Staying with the Trouble* Donna Haraway provides another trajectory beyond the closures of cybernetics: a shift from responsiveness to response-ability through a relational ontology grounded in sympoietic entanglement. Haraway, who has critically and innovatively enfolded cybernetic ideas into her work since the mid-1980s,

articulates the notion of sympoiesis as an opening-up of the concept of autopoiesis. Through drawing on insights from biology, such as Lynn Margulis's characterisation of symbiogenesis in bacteria, Haraway refutes the dominance of self-referentiality: 'nothing makes itself; nothing is really autopoietic or self-organizing ... Sympoiesis enfolds autopoiesis and generatively unfurls and extends it.'<sup>90</sup>

Sympoiesis, making-with, comprises a non-anthropocentric and radically experimental form of collective production. As Hörl argues, sympoiesis expands Marx's human-centred analysis of production, constituting a non-anthropocentric and 'radically environmental reconceptualization of the production and formation of [the] world as such in terms of a movement of the real itself'.<sup>91</sup> Thereby, it provides a counter-model to the un-worldings of Environmentality in the form of trans-worldings.<sup>92</sup> Sympoiesis also figures as a key motif in Chandler's notion of hacking, an affirmative and interactive ontopolitical strategy that transcends the modernist baggage of autopoietic-mapping and homeostatic-sensing.<sup>93</sup> The notion of the hack is understood as an intervention 'to reveal and to construct new relations and interconnections: it does not seek to construct new forms ... but neither does it passively accept the world as it is.'<sup>94</sup> As cultural theorist McKenzie Wark explains, 'the hack produces a production of a new kind ... every production is a hack formalised and repeated on the basis of its representation. To produce is to repeat; to hack, to differentiate.'<sup>95</sup>

As an ontology of entanglement, sympoiesis thus becomes the basis for experimentation and action by way of making new relations, for 'stay[ing] with the trouble of living and dying in response-ability on a damaged earth'.<sup>96</sup> Haraway develops the concept of response-ability from a study on plant-insect entanglements by feminist scholars Carla Hustak and Natasha Myers, who describe it as a feminist ethic 'in which questions of species difference are always conjugated with attentions to affect, entanglement, and rupture; an affective ecology in which creativity

and curiosity characterise the experimental forms of life of all kinds of practitioners, not only the humans.<sup>97</sup> Sympoiesis thus refutes the contemporary tendency of flat ontologies to either foreground the withdrawal of things or over-emphasise connectivity to exhaustion. As Haraway succinctly remarks: 'nothing is connected to everything; everything is connected to something'.<sup>98</sup> Understanding relations as partial and contingent in turn leads to a call for the creation of new material-semiotic entanglements, a speculative fabulation. This is an inherently political production: not a mere responsiveness but a matter of care, a response-able pursuit of the tentacular connections through experimental worldings in a thick present:

eschewing futurism, staying with the trouble is both more serious and more lively. Staying with the trouble requires making oddkin; that is, we require each other in unexpected collaborations and combinations, in hot compost piles. We become-with each other or not at all. That kind of material semiotics is always situated, someplace and not noplacé, entangled and worldly.<sup>99</sup>

Haraway's unfurling and extension of autopoiesis as sympoietic response-ability also urges a renewed ethics and politics of collective production in architecture, landscape and urbanism. This would be a cosmopolitics of partial, asymmetrical and more-than-human relations, manifest in experimental practices of designing-with the myriad of entities bound up with our already-entangled selves.

### **Conclusion**

The course of cyberneticisation that accelerated the eclipse of modernity and propelled the generalisation of ecology has been far from inevitable. In turn, the contradictory circuits of cybernetics in contemporary architectural discourse examined in this article are given new context by reconsidering them within the environmentalitarian epoch. Cybernetics is today simultaneously exalted as a liberatory mechanism for designing emergence, complexity and open-endedness, yet also constitutive of an

indiscernible mode of decentralised, environmentally modulated control. Such strategies of indirect control have permeated architecture, landscape and urbanism under various guises: adaptation, responsiveness, cultivation, resilience, conversation, and more. While promising freedom from modernist rigidities, these quasi-cybernetic approaches inherently operate along the same logics as the restrictive ontopolitics of Environmentality. Rather than passively accepting these cybernetic entanglements, questioning, probing, refuting, and eclipsing them are necessary steps towards a critical reevaluation of becoming-environmental.

If coming to terms or composing with Gaia is the question of our epoch, the task for designers is to develop new material practices that transcend the fundamental convictions of cybernetic ontology – its self-referentiality and banishing of chance. These new practices require not only a critique of what has come before – a clear-eyed understanding of the homologies of control, capital, neoliberal governance, and architecture under Environmentality – but also new ways of thinking how to live and make together. The heterodox extrapolations of cybernetics evinced by Yuk Hui and Donna Haraway both make the case for new cosmopolitics beyond Environmentality. A common thread running across their interventions is the urgency for designers to adopt an attitude of 'daring humility': a disposition of both speculation and care towards environments out of our control. Through fortuitous modulations and sympoietic experimentations, they unfold cybernetic circuits – reaffirming immanent difference and collective entanglement – on a delightfully messy and open-ended path toward new practices.

## Notes

1. Bruno Latour, *Facing Gaia: Eight Lectures on the New Climatic Regime* (Cambridge: Polity, 2017), 140–41.
2. Donna J. Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC: Duke University Press, 2016), 33.
3. Yuk Hui, *Recursivity and Contingency* (London: Rowman & Littlefield, 2019), 273.
4. Isabelle Stengers, *In Catastrophic Times: Resisting the Coming Barbarism* (London: Open Humanities Press, 2015), 43–50.
5. *Ibid.*, 48.
6. *Ibid.*, 50.
7. The term 'Anthropocene' to describe our epoch is debated. See: Jason Moore, ed., *Anthropocene or Capitalocene? Nature, History and the Crisis of Capitalism* (Oakland, CA: PM Press, 2016).
8. Erich Hörl, 'Introduction to General Ecology: The Ecologization of Thinking', in *General Ecology: The New Ecological Paradigm*, ed. Erich Hörl and James Burton (London : Bloomsbury Academic, 2017).
9. Erich Hörl, 'The Environmentalitarian Situation: Reflections on the Becoming-Environmental of Thinking, Power, and Capital', *Cultural Politics* 14, no. 2 (July 2018): 153–73.
10. Andrew Pickering, 'Cybernetics', in *International Encyclopedia of the Social & Behavioral Sciences* (Elsevier, 2015), 645.
11. Robert Hurley, 'Preface: Hypothesis on the Hypothesis', in Tiqqun, *The Cybernetic Hypothesis* (London: Semiotext(e), 2020): 9.
12. Gilbert Simondon, *L'individuation à la lumière des notions de forme et d'information* (Paris: Éditions Jérôme Millon, 2005), 45–48; Gilles Deleuze, 'Postscript on the Societies of Control', *October* 59 (1992): 3–7.
13. Fredrik Torisson, 'The Cybernetic Hypothesis & Architecture', *Histories of Postwar Architecture* 1, no. 1 (2017): 11–12, emphasis added.
14. Gordon Pask, 'The Architectural Relevance of Cybernetics', *Architectural Design* vol. 39 (September 1969): 494–96; Sean Wellesley-Miller, 'Self-Organizing Environments', in *Design Participation*, ed. Nigel Cross (London: Academy Editions, 1972), 58–62.
15. For an overview of the cultivation mentality, see Roy Cloutier and Nicole Sylvia, 'Architecture After Cultivation: Four New Grids for the Great Plains' (Master's thesis, University of British Columbia, 2016), online at <[https://issuu.com/roycloutier/docs/masters\\_thesis\\_-\\_roy\\_cloutier\\_and\\_n](https://issuu.com/roycloutier/docs/masters_thesis_-_roy_cloutier_and_n)>.
16. Roy Cloutier, "'Absolutely Safe, Completely Unpredictable": Control and Indeterminacy in the Atomic Garden', *SITE Magazine* 40 (2019): 92–102. On critical spatial praxis, see: Nishat Awan, Tatjana Schneider, and Jeremy Till, *Spatial Agency: Other Ways of Doing Architecture* (London: Routledge, 2011). On cybernetics and conversation, see Thomas Fischer and Christiane M. Herr, eds., *Design Cybernetics: Navigating the New* (Cham, Switzerland: Springer, 2019).
17. Kees Lokman, 'Cyborg Landscapes: Choreographing Resilient Interactions between Infrastructure, Ecology, and Society', *Journal of Landscape Architecture* 12, no. 1 (January 2017): 72.
18. Socrates Yiannoudes, *Architecture and Adaptation: From Cybernetics to Tangible Computing* (London: Routledge, 2016), 4.
19. Torisson, 'The Cybernetic Hypothesis', 10. See also Robert Somol and Sarah Whiting, 'Notes around the Doppler Effect and Other Moods of Modernism', *Perspecta* 33 (2002), 72–77.
20. Luciana Parisi, 'Computational Logic and Ecological Rationality', in *General Ecology: The New Ecological Paradigm*, ed. Erich Hörl and James Burton (London : Bloomsbury Academic, 2017), 83.
21. Lokman, 'Cyborg Landscapes', 63.
22. Hörl, 'Introduction to General Ecology', 8. Note on capitalisation: in keeping with Hörl's use of the terminology, 'Environmentality' denotes the contemporary mode of governmentality, as used by Foucault, whereas 'environmentality' refers to a broader sense of the environmental.
23. *Ibid.*, 1.
24. *Ibid.*, 2–3.

25. Erich Hörl, 'The Environmentalitarian Situation: Reflections on the Becoming-Environmental of Thinking, Power, and Capital', *Cultural Politics* 14, no.2 (July 2018): 159.
26. Ibid.
27. Ibid., 154.
28. Ibid., 157.
29. Daniel Barber, 'Environmentalisation and Environmentality: Re-Conceiving the History of 20thc Architecture', *Design Philosophy Papers* 7, no. 3 (November 2009): 148. See also Sven-Olov Wallenstein, *Biopolitics and the Emergence of Modern Architecture* (New York: Princeton Architectural Press, 2008).
30. Ibid., 149–51.
31. Hörl, 'Introduction to General Ecology', 4–5, emphasis added. On the extended history of cybernetics stretching to at least the mid-nineteenth century, see also Alexander Galloway, 'The Cybernetic Hypothesis', *Differences* 25, no. 1 (January 2014): 107–31.
32. N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999).
33. N. Katherine Hayles, 'Unfinished Work: From Cyborg to Cognisphere', *Theory, Culture & Society* 23, no. 7–8 (2006): 161.
34. Ibid., 164.
35. Hayles, *How We Became Posthuman*, 13.
36. Ariane Lourie Harrison, *Architectural Theories of the Environment: Posthuman Territory* (London: Routledge, 2013), 3–33. Donna Haraway, *Simians, Cyborgs and Women: The Reinvention of Nature* (New York: Routledge, 1991), 149–81.
37. Harrison, 'Charting Posthuman Territory', 8.
38. Hörl, 'Introduction to General Ecology', 9 and 48–49, note 20; Andrew Goffey, 'Towards a Rhizomatic Technical History of Control', *New Formations* no. 84/85 (2014): 58–73.
39. Ibid., 9. It is worth noting that third-order cybernetics has been recently theorised as 'self-developing reflexive-active environments.' See: Stuart A. Umpleby et al., 'Recent Developments in Cybernetics, from Cognition to Social Systems', *Cybernetics and Systems* 50, no.4 (May 2019): 367–82.
40. Ibid., 9–10.
41. Erich Hörl, 'Luhmann, the Non-Trivial Machine and the Neocybernetic Regime of Truth', *Theory, Culture & Society* 29, no. 3 (May 2012): 94–121; Tiqqun, *The Cybernetic Hypothesis*, trans. Robert Hurley (London: Semiotext(e), 2020).
42. David Chandler, *Ontopolitics in the Anthropocene: An Introduction to Mapping, Sensing and Hacking* (London: Routledge, 2018).
43. Ibid., xiii, 21.
44. Ibid., 21.
45. Ibid., 42.
46. Ibid., 22.
47. Ibid., 55.
48. Alexander R. Galloway and Eugene Thacker, *The Exploit: A Theory of Networks* (Minneapolis: Minnesota University Press, 2007), 35. Quoted in Torisson, 'The Cybernetic Hypothesis', 5.
49. Torisson, 'The Cybernetic Hypothesis', 14, original emphasis.
50. Ibid., 13.
51. Hurley, 'Preface: Hypothesis on the Hypothesis', 9.
52. Douglas Spencer, *The Architecture of Neoliberalism: How Contemporary Architecture Became an Instrument of Control and Compliance* (New York: Bloomsbury Academic, 2016).
53. Ibid., 45.
54. Torisson, 'The Cybernetic Hypothesis', 14.
55. Chandler, *Ontopolitics in the Anthropocene*, 22.
56. Ibid., 94.
57. Ibid., 107.
58. Halpern, 'Repeating: Cybernetic Intelligence', in *Design Technics: Archaeologies of Architectural Practice*, ed. Zeynep Çelik Alexander and John May (Minneapolis : University of Minnesota Press, 2019), 203.
59. Ibid., 209.
60. Chandler, *Ontopolitics in the Anthropocene*, 129.
61. Maroš Krivý, 'Towards a Critique of Cybernetic Urbanism: The Smart City and the Society of Control', *Planning Theory* 17, no. 1 (February 2018): 21–22.



62. Ibid., 23.
63. John May, 'Afterword: Architecture in Real Time', in *Design Technics: Archaeologies of Architectural Practice*, ed. Zeynep Çelik Alexander and John May (Minneapolis : University of Minnesota Press, 2019), 238, emphases in original.
64. John May, 'Logic of the Managerial Surface', *Praxis* no. 13 (December 2012): 123.
65. Ibid., 121.
66. May, 'Afterword', 238.
67. Chandler, *Ontopolitics in the Anthropocene*, 131.
68. Ibid., 164, emphasis added; Claire Colebrook, *Death of the Posthuman: Essays on Extinction, Vol. 1* (Ann Arbor: Open Humanities Press, 2014).
69. Luigi Pellizzoni, *Ontological Politics in a Disposable World: The New Mastery of Nature* (London: Routledge, 2016), 8.
70. David Chandler, 'The Transvaluation of Critique in the Anthropocene', *Global Society* 33, no. 1 (January 2019): 26–44.
71. Hörl, 'Introduction to General Ecology', 3.
72. Halpern, 'Repeating: Cybernetic Intelligence', 212.
73. Hörl, 'Introduction to General Ecology', 5.
74. Isabelle Stengers, 'The Cosmopolitical Proposal', in *Making Things Public: Atmospheres of Democracy*, ed. Bruno Latour and Peter Weibel (Cambridge, MA: MIT Press, 2005), 994–1003.
75. Hui, *Recursivity and Contingency*, 16–17.
76. Ibid., 270, emphasis in original.
77. Ibid., 192–93.
78. Ibid., 18.
79. Ibid., 14, 20.
80. Simon Mills, *Gilbert Simondon: Information, Technology, and Media* (London: Rowman & Littlefield, 2016), 22–23.
81. Gilbert Simondon, *On the Mode of Existence of Technical Objects*, trans. Cecile Malaspina and John Rogove (Minneapolis: Univocal, 2017), 150, quoted in Hui, *Recursivity and Contingency*: 135. This operative notion of information is comparable to the anthropologist and second-order cybernetician Gregory Bateson's notion of information as a 'difference which makes a difference'; Gregory Bateson, *Steps to an Ecology of Mind* (Northvale, NJ: Jason Aronson, 1987), 276.
82. Hui, *Recursivity and Contingency*, 14.
83. Ibid., 195.
84. Yuk Hui, 'Modulation after Control', *New Formations* no. 84–85 (Winter 2014/Summer 2015): 88.
85. Ibid., 87.
86. Hui, *Recursivity and Contingency*, 273.
87. Ibid., 278.
88. Kane X. Faucher, *Metastasis and Metastability: A Deleuzian Approach to Information* (Rotterdam: Sense Publishers, 2013), 218.
89. Keller Easterling, *Medium Design* (Moscow: Strelka Press, 2017), unpaginated e-book.
90. Haraway, *Staying with the Trouble*, 58.
91. Hörl, 'The Environmentalitarian Situation', 165.
92. Ibid., 164.
93. Chandler, *Ontopolitics in the Anthropocene*, 22–23, emphasis added.
94. Ibid., 146.
95. McKenzie Wark, *A Hacker Manifesto* (Cambridge, MA: Harvard University Press, 2004): 158–60.
96. Haraway, *Staying with the Trouble*, 2.
97. Carla Hustak and Natasha Myers, 'Involuntary Momentum: Affective Ecologies and the Sciences of Plant/Insect Encounters', *Differences* 23, no. 3 (2012): 106.
98. Haraway, *Staying with the Trouble*, 31.
99. Ibid., 4.

**Biography**

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