DIGITAL ARCHITECTURE AND DIFFERENCE

A theory of ethical transpositions towards nomadic embodiments in digital architecture

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PhD Thesis

Declaration

I, Tal Bar, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

This thesis contributes to histories and theories of digital architecture of the past two decades, as it questions the narratives of its novelty. The main argument this thesis puts forward is that a plethora of methodologies, displacing the centrality of the architect from the architectural design process, has folded into the discipline in the process of its rewriting along digital protocols. These steer architecture onto a post-human path. However, while the redefinition of the practice unfolds, it does so epistemically only without redefining the new subject of architecture emerging from these processes, which therefore remains anchored to humanist-modern definitions. This unaccounted-for position, I argue, prevents novelty from emerging. Simultaneously, the thesis unfolds a creative approach – while drawing on nomadic, critical theory concepts, there surfaces an alternative genealogy already underpinning digital methodologies that enable a reconceptualization of novelty framed with difference to be articulated through nomadic digital embodiment.

Regarding the first claim, I turn to the narratives as well as to the mechanisms of digital discourse emerging in two modes of production – mathematical and biological – in exploration of the ways perceptions of novelty are articulated: a) through close readings of its narratives as they consolidate into digital architectural theory (Carpo 2011; Lynn 2003, 2012; Terzidis 2006; Migayrou 2004, 2009); b) through an analysis of the two digital methodologies that support these narratives – parametric architecture and biodigital architecture. In parallel, this thesis draws on twentieth-century critical theory and twenty-first-century nomadic feminist theory to rethink two thematic topics: *difference* and *subjectivity*. Specifically, these are Gilles Deleuze's non-essentialist, non-representational philosophy of difference (1968, 1980, 1988) and Rosi Braidotti's nomadic feminist reconceptualization of post-human, nonunitary subjectivity (2006, 2011, 2015). Nomadic feminist theory also informs my methodology. I draw on Rosi Braidotti's *cartographing* and *transposing* (2006, 2011) because they engender a non-dualist approach to research itself that is dynamic and affirmative, insisting on grounding techniques – grounding in

subject positions that are nevertheless post-human and nonunitary. This leads to a redefinition of novel digital practices with ethical ones.

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INTRODUCTION

This thesis explores narratives of novelty in digital architecture, developed over the past 20 years in architectural history and theory literature, digital architecture exhibitions, monographs, technical literature and lectures, digital software and projects. It challenges the main claims for a paradigm shift in architecture from a humanist-centred architectural discourse and towards a post-humanist architectural production (Lynn 2004; Carpo 2004, 2011, 2013; Terzidis 2006; Picon 2010; Bury 2010; Legendre 2012). Secondly, by drawing on post-structuralist theory (Deleuze 2004 [1968], 2015 [1969], 1980, 2006 [1988]; Deleuze and Guattari 2004 [1972], 2004 [1980]), and nomadic feminist theory (Braidotti 2006, 2011, 2015), my thesis aims to redefine novelty in terms of difference, and difference in terms of nomadic practices, which challenges digital architecture's perceptions of subjectivity, materiality and ethics.

My main argument is that novelty in digital architecture is hindered because of its uncharted discursive stand that traps digital practices and narratives between the two traditions: the humanist and the post-humanist. That is to say, digital architecture operates post-humanist methodologies but remains immersed in humanist ontology. In parallel I develop a second argument, maintaining that we need new definitions of *the human* in digital architecture discourse for novelty understood as qualitative difference to arise. It is therefore the aim of this thesis to account for digital architecture's discursive hybridity and to reclaim post-human and nomadic ontologies by focusing on developing digital subject conceptions.

In constructing the thesis, I distinguish between two different discursive materialities as my subjects of study. The first is narrational sources, in the format of professional publications (*Folding in Architecture* 1993, 2004),

historical and theoretical architectural literature (Carpo 1993, 2004, 2011, 2013; Picon 2010), technical digital literature (Terzidis 2006), exhibitions (*Non-Standard Architecture* 2003–04; *Scriptedbypurpose* 2007) and lectures (Migayrou 2009). The second subject of study is digital architecture methodologies, where the objects of study are architectural projects, primary source professional literature and digital architectural software. Further, I distinguish between two digital architecture practices, underpinned by two distinct methodologies: a mathematical practice (1993–) (Lynn 1993, 1998, 2004; Carpo 2004, 2011, 2013; Terzidis 2006; Picon 2010; Bury 2010, 2011; Rutten 2010; *Grasshopper* software), and a biodigital practice (1995–) (Frazer 1995; Michael Hensel, Achim Menges and Michael Weinstock 2004, 2006, 2010, Marie-Ange and Migayrou 2013; Achim Menges, 2015).

Nomadic feminist theory also informs the methodology of this thesis. Throughout the thesis I draw on two non-dualist methodologies developed by Rosi Braidotti (2006, 2011). I use *Cartographing* (Braidotti 2006, 30–32; 2011, 215–19) as a methodology towards the first critical aim of the thesis, as a means to situate digital architecture in the materialities and disciplines that underlie it, because I maintain that this methodological approach better accounts for the above-mentioned discursive hybridity and the mechanisms that support it, which are rooted in our current socio-political modes of operation. Cartographing as a cross-disciplinary, dynamic methodology enables me to extend my research to the sub-levels of these two distinct bodies of study, the mathematical and the biological. Accordingly, cartography 1 is aimed at the *narratives* of novelty of digital architecture. It enables me to theorize the convoluted state of the discourse as caught between two thought traditions, the humanist and the post-humanist (for example, in the work of Lynn 1993, 2004; Carpo 2004, 2011; Terzidis 2006) by reaching to the underlying tendencies that render this state possible. The first cartography suggests an alternative reading of digital histories and convention of narration; it does not seek to suggest an alternative time line, but rather an alternative reconceptualization of post-formal practice in digital architecture history, branched along the following three themes/ practices: *Folding, Non-Standard* and the *Algorithm*. Cartography 2

targets digital *practices and methodologies* in architecture. The first of these elaborates on a mathematical-formal body of work developed in digital architecture over the past 20 years, where I point to a misconception behind the mathematical traditions underpinning the new architectural mathematics – that of *topology* which leads it in formal and axiomatic routes, both of which are humanist practices (for example, in the work of Legendre 2010; DeLanda 2002; Burry 2010). This cartography also suggests that the mathematical operations underpinning digital parametric methodologies have internalized these axiomatics. My cartography enables me to then retie digital mathematical practice with forgotten post-humanist mathematical genealogy (Deleuze 2004 [1968], 1980, 2006 [1988]; Duffy 2010), which I redefine as a nomadic, nonunitary practice. The second part of this cartography explores the premise of biodigital architectural methods and histories, where my analysis brings me to equate biodigital architecture with humanist deterministic and universalist methodologies, despite its advocacy of complex and post-formal *emergent* methodologies (which underlie the work of Weinstock, Menges and Hensel 2010). Cartographing enables me then to link biodigital discourse with alternative post-human evolutionary thinking (Deleuze and Guattari 2004 [1980]; Ansell-Pearson 1999; Grosz 2011) that defy reductive genetically oriented evolutionary processes of differentiation and allows then for their reconceptualisation along nomadic, multiple lines. In both these cases, cartographing exposes a forgotten nomadic ontological thread subsumed by humanist ontologies; this alternative genealogy suggests a creative, non-dualist and *embodied* understanding of the processes under consideration.

This brings me to the second methodology: that of *transposing* (Braidotti 2006, 5–8, 43–95). This is a methodology that I put in place as a means of resisting by reclaiming the forgotten nomadic practices to which I point in the first two cartographies, transposing is inseparable from the cartographic process and is perceived as a continuation of the creative, affirmative path already traced by them. In Chapter 3 therefore, I continue to transpose novelty in digital discourse from its hijacked position as part of neoliberal practice to an embodied, non-dualist and multiple location that unites novelty with an ethical position, framed

with nomadic and feminist discourse. Ethics in this respect cannot be separated from a subject position. This thesis is not seen as a disembedded and disembodied intellectual undertaking; this is my own subject location, developed as part of my experience as a Master's student in histories and theories of architecture at the *Architectural Association School of Architecture* in London in 2006 and where the need for a new methodology to theorize digital architecture became apparent to me.

The themes and methodologies covered as part of my MA course consisted mainly of modernity and postmodernity's architectural discourse. The historical and theoretical methodologies needed for engaging with this materiality consisted of the functional/aesthetic viewpoints and their capacity to address social and urban environments. The historical and theoretical process entailed engaging with the materiality of this architectural discourse, dissected into plans/ elevation/ sections/ perspective and tracing a design methodology, an architectural psych represented through these individual parts. This analysis corresponded to architectural notation as ontology – emerging from a centred, rational subject position.

In parallel with my course, the Architectural Association (AA) ran an experimental architectural post-graduate programme – DRL – Design Research Lab (founded in 1997), led by Brett Steele, Patrik Schumacher and Tom Verebes. The DRL was experimenting with new concepts in digital architectural production, with architectural methodologies that operated systems and concepts far removed from those taught in our seminar rooms. The AA library had dedicated individual shelves for each unit with their relevant reading. The DRL shelves were dedicated to catastrophe and complexity theory positing a world out of equilibrium and out of control. It also contained *Folding in Architecture* as well as Deleuze's *The Fold* and Deleuze and Guattari's *A Thousand Plateaus*. Histories and Theories shelves held modernist history and theory (Giedion, Le Corbusier, Johnson and many others) and postmodernist theory (Rossi, Venturi and Scott Brown, Tschumi, Eisenman and Koolhaas, framed by Vidler, Kwinter and Somol, amongst many others). We discussed topology with

Durand, structuralism with Saussure and Roland Barthes and aesthetics with Kant's *Critique of Judgment*.

Sitting in DRL reviews, it was evident to me that we, historians and architects alike, lack concepts, discursive and analytical tools for framing these digital experimental projects, new criteria for debate and design and methodological tools to address the architects' own narratives. These could not have been met by applying traditional historical approaches which were used to theorize and debate a humanist-based design process and product. This pedagogical void is summed up by a quote attributed to a former DRL director during a review, who is remembered as having said – 'We have nothing to teach you!' (Hight 2008, 29). Are we really in the presence of a utopian tabula rasa? What forces do we expect to invade such a seemingly non-restricted world? I believe that we should account for these shifts; I equally believe that we cannot account for them while holding on to methodologies emerging from a humanist perspective. This thesis is therefore dedicated to accounting for these shifts and for theorizing alternative to humanist-centered research and design methodologies.

MAIN THEMES

Subsuming Digital Narratives

The histories, theories and criticism of digital architecture over the past two decades base their claim that the digital architectural paradigm is new on the grounds of the production of alternative processes to the traditional linear and projective design practice. These alternative processes, so the narrative goes on to claim, have replaced the main architectural paradigm of the past five centuries, established by Alberti in his treatise *On Architecture* (1452) (Carpo 2011).[1] A narrative of novelty ensues, claiming complex, non-formal, materialist

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[1] Mario Carpo, to whom I refer in cartography 1, associates modernity with Alberti's treatises *On architecture* (1452), which codified the centrality of the architect and the division of labour between the architect and the builder, as well as defining the main methodology that corresponds to this separation and to the architect as a focal point of creation through the introduction of projective architectural processes: plans, elevations, perspectives, etc. Carpo claims this tradition is stretched therefore from the Renaissance and until the shift to digital

and post-humanist methodologies, enabled in architecture by the shift from Euclidian mathematics to topology in the case of mathematically based digital architecture (Lynn 1993; Eisenman 1993; Carpo 2004; Terzidis 2006; Legendre 2011), and from formal to morphogenetic processes in the case of biodigital architecture, a methodological shift that is explained by the digitization of topological procedures into parametric practice (Terzidis 2006; Carpo 2011; Parisi 2013) and biological evolutionary processes[2] (Frazer 1995; Weinstock, Menges and Hensel 2006, 2010).

The first narrational framing of a shift in architectural thinking is attributed to a special issue of *Architectural Design* magazine, guest-edited by Greg Lynn and entitled *Folding in Architecture* (1993, reprinted 2004). This issue captures new thinking in architecture, despite its paradoxically capturing pre-digital practice in architecture (as the work presented in *Folding in Architecture* was predominantly developed in detachment from digital tools). It is important to understand the American architectural discursive context at the time, which was immersed in an ongoing postmodernist debate. The stylistic postmodern convention in the early 90s was deconstructivism,[3] which approaches urban/ programmatic diversity by representing fractions formally, leading to a visually and programmatically fragmented architectural effect.[4] In *Folding in Architecture,* deconstructivism is referred to as the catalyst for the widespread interest exhibited in a new mathematical model – that of topology, which was suggested to replace deconstructivism in particular and postmodernism in architecture in general while eschewing the formal and binary-based approach of deconstructivism to the architectural site (Eisenman 1992; Lynn 1993, 2004b; Kipnis 1993; Carpo 2004; Picon: 2010). Topology, the study of properties of spaces that do not change under a continuous transformation (that is,

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architecture. See Mario Carpo, *The Alphabet and the algorithm*, (Cambridge, Massachusetts/ London: MIT Press Book, 2011).

[2] A pioneer in this field was John Holland who in the 60s and 70s developed genetic

[3] See Cartography 1, part 1, for an historical overview.

[4] The Museum of Modern Art, New York held an exhibition of *Deconstructivist Architecture* (1988), curated by Philip Johnson and Mark Wigley. The press release described the new architectural style as 'Obsessed with twisted shapes, warped planes, and folded lines, they [the emergent new architects] intentionally violate the pure forms of modern architecture. The traditional virtues of unity, harmony, and clarity are displaced by fracturing, disharmony, and mystery' (Deconstructivist Architecture 1988).

translation, rotation and stretching without tearing),[5] was therefore proposed as an alternative to deconstructivist formal fragmentation. The interest in developing topological models in architecture in this publication is attributed to Deleuze's *The Fold: Leibniz and the Baroque* (1988). *The Fold*'s English translation was first available in 1993 and chapter 1 of the book appeared unabridged and unedited in *Folding in Architecture*, alongside the convention of architectural projects and text.

Folding in Architecture is repeatedly rehearsed as the moment of digital architecture's inception and, as such, as containing the 'official narrative' of digital architecture on the part of historians and architects alike.[6] This official narrative speaks of *folding* as a new architectural style. I suggest an alternative reading of this narrative of inception, according to which *Folding in Architecture* is an interesting discursive moment in architectural history because it captures the generation of architects trained in postmodernist thought, such as Eisenman and Lynn, who grasp the importance of Deleuze's development of topological thinking in *The Fold* as post-formal. For example, Eisenman frames topological models as an opportunity to replace the centrality of vision and the fixity and centrality of the Cartesian grid (Eisenman 2004a [1993], 40), and at the same time describes *folding* as a formal response to deconstructivist fragmentation.[7] However, and despite this and other examples of the fact that Deleuze's overall post-humanist concepts are registered by this generation of architects (Eisenman, Kipnis and Lynn) who are well-versed in Deleuze and Guattari's earlier writing, *A Thousand Plateaus*,[8] the overall 'translation' of topological thinking as an architectural methodology manifested in the project and texts presented in *Folding in Architecture* is premature and, moreover, there is an overall misconception of Deleuze's mathematical project. Lynn, as well as Eisenman, perceives *folding* as a project of *continuity* (Lynn 2004).

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[5] See Cartography 2, part 1 for a detailed discussion.

[6] See Cartography 1, narrative 1, 1 for the full historical discussion.

[7] Ibid., for a detailed discussion on Eisenman's narrational role.

[8] The first English translation by Brian Massumi of *A Thousand Plateaus: Capitalism and Schizophrenia* was published by the University of Minnesota Press (Minneapolis, London), 1987. The original manuscript was published as *Mille Plateaux,* volume 2 of *Capitalisme et Schizophrenic* © 1980 by Les Editions de Minuit, Paris.

I discuss at length this misconception of Deleuze's project in the context of this introduction because I would like to point to an interesting convoluted outcome, where *continuity* became the official novelty narrative of digital architecture, while the Deleuzian post-humanist ontology prominent in *Folding in Architecture* disappears from later official narratives (for example, in Carpo 2004; Lynn 2004). Omitted from the narrative, therefore, is Deleuze's non-dualist, non-representational, post-human and nomadic ontology as well as the specificity of Leibniz's *differential calculus* as a relational, non-dualist differentiation mechanism of which its formal manifestation is a derivative, not its driver, a notion that Deleuze develops in various writings (Deleuze 2004 [1968]; 2004 [1980]; 2006 [1988]). These omissions from the architectural narrative to follow reduce *The Fold* to a metaphor for the architecture of continuity (Lynn 1993, 2004; Carpo 2004).

The consolidation of digital discourse that followed after this early pre-digital phase with the appearance of digital platforms towards the end of the 1990s continued that tendency to disembedded folding methodology, resulting in *folding* becoming synonymous with formal exuberant continuity (for example, in Picon 2010; Cache 2011). Digital architecture was moving rapidly in an ontological void enhanced by the 'end of theory', 'post-critical' tendency of the end of the millennium.[9]

In the context of this thesis, this forgetfulness is seen in light of Braidotti's analysis of a broader and more general tendency of subsumption occurring in our advanced capitalist location, where the neoliberal mutation machine efficiently adapts to any form of resistance by techniques of subsumption.

Subsuming Digital Practices

The general term 'digital architecture' masks the amalgamation of practices and methodologies deriving from disciplines external to architecture – namely, mathematics and biology, which two disciplines currently, in contrast to past reliance on their methodologies, operate at a sub-level to the computational

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[9] See Cartography 1, Narrative 1.

level. In cartography 2, I uncover the computational operational system at the level of the architect; the software Grasshopper is discussed in part 1 of this cartography, while emergent morphogenetic computational techniques are discussed in part 2, as well as the deep structures and ontologies that operate it. In cartography 2, part 1, I reconnect the differential calculus (Deleuze 2006 [1988], 1980; Duffy 2013) as underlying topological architectural methods (Grasshopper software). In part 2, I discuss the Darwinian evolutionary process underlying *genetic algorithms* (Holland 1993 [1975], Mitchell; 2001, 2011), and the computational conventions that underlie biodigital projects (Weinstock, Menges and Hensel 2006, 2010). In the case of topological models, I expose axiomatic and formalist interpretations to the differential calculus, while in the biodigital case I uncover deterministic and universal dated biological models underlying the development of genetic algorithms – these are humanist traditions that lie beneath claims to post-humanist discourse.

Architects trained in these digital practices are removed from humanist residues underpinning their methodologies but, more importantly, they are also removed from their ontologies – removed because of mitigating computational platforms that translate and integrate these discursive sub-layers into architectural software. But even at the level of the script, there is a removal occurring between the architect and these disciplines because of its translation to computer codes, to algorithms. This removal, I show, renders the epistemic and ontological aspect of these disciplines neutral and, moreover, natural. I argue that this unaccounted-for amalgamation in both the mathematical and the biodigital cases bars us from the production of real novelty; rather, what is being produced are undifferentiated formal solutions, which still operate under unaccounted for modern ontologies.[10]

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[10] I distinguish between two terms: *Modern/ Modernity* and *Modernism*. Digital architecture historians such as Mario Carpo and Antoine Picon delimit *Modern* in the architectural project from its codification by Alberti until the introduction of digital tools in the production of architecture which is defined by central, linear and hierarchical and projectional practice. See Carpo, *The Alphabet and the Algorithm*, 2011: 71–83; Picon, *Digital Culture in Architecture* (Basel: Birkhäuser, 2010), 8. I agree with Carpo on the watershed point from pre-modern practices, although I disagree that the shift is indeed complete. *Modernism* in architectural terms, on the other hand, is the architectural project within modernity that runs from the late 20s of the last century to the late 60s. See Henry-Russell Hitchcock and Philip

These processes, however, are neither natural nor neutral; rather, they are tainted with axiomatic, universalist, deterministic and positivist ontologies immersed, unaccounted for, into digital architectural production. I argue, therefore, that the narratives that describe the shift from postmodernist to digital on the grounds of a shift from humanist, formal to post-humanist, post-formal (folded/ non-standard/ algorithmic/ emergent) architectures are founded on a thin façade of post-humanist thinking that operates at the interface with the architect only, at the computational 'exposed' layer. It is therefore the aim of this thesis to expose both the reliance of current digital practices on humanist ontologies, which is the concern of Cartographies 1 and 2. This thesis is also concerned with suggesting the retying to current digital thinking of forgotten nomadic traditions in mathematics and biology that bypass these humanist traditions. Discussing the relevance of these predominantly post-human traditions to current digital discourse, I argue, repositions questions of novelty with a new definition of ethics.

Non-dualist, Embodied, Digital Relationality

Beyond pointing to the insufficiencies of the discourse to account for and to produce qualitative difference,[11] in cartography 2 I also argue for the importance of pursuing pre-human ontologies underpinning the mathematical methodologies and non-human ontologies underpinning the biologically influenced digital architectural methodologies as a means of introducing subject position as a first step towards an ethical practice. To this end, cartography 2 insists on an alternative genealogy to the topological and biodigital processes in architecture to replace the predominantly axiomatic and formal interpretation of the differential calculus that underlies the topological digital tools, and the deterministic, universalist evolutionary processes that direct biodigital discourse.

In the case of the first part of cartography 2, I refer to an example of a pre-human articulation of embodied subjectivity that underlies topological and therefore

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Johnson, *The International Style* (New York, London: W.W. Norton & Company: 1966 [1932]) on the codification of the movement eraly days as a new style.

[11] Qualitative difference is a term used by Rosi Braidotti to account for the non-differentiated difference see Introduction, *Nomadic theory section.*

parametric digital processes, namely to Leibniz's infinitesimal aspect of the calculus, which unfolds a relational, non-dualist and embodied differentiation mechanism (Deleuze 2006 [1988], 1980; Duffy 2013). Drawing on this alternative lineage that connects current digital methodologies with Leibniz's articulation of the infinitesimal (a process begun by Deleuze and elaborated on by Duffy) enables me to position Leibniz's mechanism of differentiation a as nonunitary–nomadic one, and therefore the first transposition is made. This lineage also exposes a shift in mathematical and philosophical thinking that redefines the differential calculus as articulating the multiple, through the mathematical heritage of three late nineteenth century and early twentieth century mathematicians: Gauss, Riemann and Poincaré. Drawing on this lineage therefore also enables me to articulate this shift to the multiple-nomadic in Deleuze's *The fold* with the above nonunitary-nomadic. This is significant because these transpositions bring to the fore the importance of a nonunitary subject position as part of a process of differentiation as already hidden part of the mathematics of the digital.

In part 2 of this cartography, I point to a non-human biological and philosophical heritage that I suggest to retie biodigital methodologies with. I refer to Elizabeth Grosz (2011) and to her reconceptualization of the Darwinian evolutionary process along embodied and sexually differentiated lines, and particularly to the work of the ethologist Jakob von Uexküll, who developed an embodied, relational, affective receptive and differentiating mechanism known as *umwelt*. I show how *umwelt* is already related to Deleuze and Leibniz pre-humanist articulation of differentiation, and how through the non-human (germinal/ molecular) aspect it adds to Deleuze and Guattari's thinking of difference, it enables the shift to a multiple and therefore also nonunitary understanding of the forces behind evolutionary processes (Deleuze and Guattari 2004 [1980]). In this discussion I also draw on the work of Keith Ansell-Pearson (1999).

In both disciplines, the mathematical and the biological influenced digital discourse; therefore, I uncover alternative genealogies that correspond to alternative scientific traditions generally framed by Deleuze and Guattari as *minoritarian* traditions in science, or *nomadic science.* Nomadic science refers to

matter as self-governed and relational – that is to say, that it forms in relation to dynamic processes, which replace fixed definitions of essence and form, matter not being explained in adherence to an external form, but rather finding its form in a dynamic relational process.[12]

> It seems that nomad science is more immediately in tune with the connection between content and expression in themselves, each of these two terms encompassing both form and matter (Deleuze and Guattari 2004 [1980], 407).

This definition of matter as a process of becoming implies a different relationality between humans and matter, as it defies the humanist-centred ideal subordination relations between man and the world. In an architectural context, also referred to in terms of *royal science*, this ontological shift has a far-reaching potential to undo the division between the master builder (the architect) and matter and the processes themselves, and I quote from *A Thousand Plateaus*:

> Royal Science is inseparable from a 'hylomorphic' model implying both a form that organizes matter and a matter prepared; it has often been shown that this schema derives less from technology or life than from a society divided into governors and governed, and later intellectuals and manual laborers (ibid.).

In the context of this thesis, these nomadic, post-human alternative concepts are thought of in terms of reclaiming practices, as recoupling the post-humanist epistemologies practised by digital architects with post-/non-/ a-human ontologies. This is seen as an act of resistance towards our digital architectural culture that celebrates the 'new' which is in fact not new. Deleuze in his early *Difference and Repetition* (1968) reminds us that:

> The new, with its power of beginning and beginning again, remains forever new; just as the established was always established from the outset […] what becomes established with the new is precisely not the new. For the new – in other words, difference – calls forth forces in thought which are not the forces of recognition [or sufficient reason, or 'Pure' reason], today or tomorrow, but the powers of a completely other

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[12] See Deleuze and Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (London, New York: Continuum International Publishing Group, 2004 [1988]), 396–407.

> model, from an unrecognised and unrecognisable terra incognita
> (Deleuze 2004 [1968], 172).

In *Difference and Repetition,* Deleuze sketches the outline for overcoming the *new, which is not new*, by undoing the dialectic, dualistic system that nurtures it and suggests replacing it with a non-representational system of relationality.[13] The alternative, pre/ non/post-human genealogies I refer to not only operate a non-dualist, non-representational, relational means of differentiation but, in addition, all emphasize an embodied element as a means of differentiation. In the case of cartography 2, part 1, this takes the form of a *perspective*, or a *point of view* in the Leibnizian metaphysics, which, through Deleuze (1980, 2006 [1988]), I show cannot be separated from the mathematics underlying the infinitesimal differential calculus. The infinitesimal is positioned as an alternative to the Newtonian interpretation of the calculus, which took centre stage throughout the eighteenth century, and found its way into the topology that underlies current parametric software (such as Grasshopper).[14] The Leibnizian process of acquiring perspective is significant because it articulates a process of relationality that is entirely generative – that is to say, none of the traits that identifies a point of view is there at the beginning of the process. The relationality is acquired via a process of differentiation, which is unique to the position of the entities in question, understood bodily as stemming from a non-cognitive, non-rational, but nevertheless non-emotional, perception. In part 2 of cartography 2, I uncover an alternative to the deterministic and universalist processes that underlie digital biodigital morphogenetic processes (Weinstock, Hensel, Menges 2010; Menges 2015). These biomimetic, evolutionary methodologies processes that understand differentiation, or evolution, as external selection forces driven by the definition of fitness. I retie these biomimetic linear and external processes of selection with an alternative understanding of forces of differentiation developed by the Austrian ethologist Jakob von Uexküll in the early twentieth century to describe an embodied ecology shared by all organisms, that produces an angle, a partiality, to replace

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[13] See the *difference* section in this introduction for a detailed discussion of Deleuze's non-representational system.

[14] See below; cartography 1, part 1 for a definition of parametric design. Broadly it can be defined as an umbrella name to digital architectural design, in frequent use since the 2010s.

the neo-Darwinian deterministic processes that rely on an active environment that select a passive organism in the evolutionary process; I refer here to the concept of *umwelt* (Grosz 2011, 174–5). I supplement this conception of an evolutionary process that is organism–oriented with Deleuze and Guattari's *machinic phylum,* which articulates the evolutionary process not in terms of the individual organism but from an angle that highlights the flows of matter that are being articulated through processes of individuation into the respective organisms (Deleuze and Guattari 2004 [1988], 451; Ansell-Pearson 1999, 140). I stress the importance of placing them together as a means of embedding the machinic flows in their respective ecologies.

It is this enhanced understanding of the importance of embodiment articulation in processes of differentiation that I bring to the fore in the last chapter, where the importance of these processes of embodiment, understood by Rosi Braidotti as forms of ethical accountability,[15] takes a socio-political turn as a means of resisting the process that allows the subsuming of nomadic discourse into advanced capitalism. Resistance in this context takes the form of reclaiming nomadic discourse, reclaiming embodied and embedded accounts of locations, which are nevertheless always partial, non-fixed and nonunitary,[16] in the pursuit of a truly differentiated ethical digital discourse in architecture. Braidotti calls these processes *transpositions*.[17] I frame this embodied figuration with Deleuze and Guattari's *artisan* (Deleuze and Guattari, 451–8), as he or she who follows matter, while stressing his or her *umwelt* as that which directs the *digital artisan* in navigating and following the flows of data. Relating data to *umwelt* rescues data from the instrumental perception, as that which resides outside the digital artisan and which is common in digital architecture discourse, and suggests instead an understanding of data that relates to all our ecologies. Perceiving and following this data requires the digital artisan to enhance his or her nonunitary position.

This thesis therefore complements the scarcity of theoretical research and critique in the field of digital architecture, as well as contributing to debates in

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[15] See *Methodology* in this introduction.
[16] See *Nonunitary subjectivity* in this introduction.
[17] See *Transpositions* in this introduction.

the fields of critical theory and the philosophy of science. In this sense, I see my investigation as part of a feminist and nomadic critique of the disembodiment of science (Haraway, Braidotti, Grosz and others) but also in proximity to current feminist thinkers who operate in the realm of a more specific investigation of the current limitations of digitally produced architecture, such as Frichot (*The Forgetting of the Ethics of Immanence,* 2012), Cogdell (*Breeding Ideologies: Parametricism and Biological Architecture,* 2015) and Rawes (*Spinoza's Geometric and Ecological Ratios*, 2015), who have expressed a recent concern with the reductive practices of parametric and emergent - biological practices, while suggesting embodied and affective approaches.

Accounting for the Academic Milieu/ Literature Review

The literature review reflects the various disciplines with which this thesis engages: digital architecture histories, theories and critique, history of mathematics, history of biomimetic computation, Deleuze's theories, and feminist and nomadic theory. This disciplinary divide is reflected in the structure of the thesis, and I therefore address this review according to the respective chapters.

History and Theory Sources

Digital architecture novelty narratives are the materiality of the first cartography and the departure point for the discussion to follow in the thesis. In my investigation of the question of novelty I specifically target the means by which the digital is framed as a shift away from human-centred architectural practice. The most prolific architectural historian to engage with digital architecture over a span of the past 20 years is Mario Carpo. His scholarship draws on the history of science and technology, especially pre-modern technologies, to conceptualize the turn to the digital. He is one of the first historians to theorize the move to digital algorithms in architecture framed in its capacity of changing the object of architecture as well as the subject – redefining the premise and boundaries of the architect as standing outside of modernity. In *The Alphabet and the Algorithm* (2011), Carpo locates novelty in the *algorithm,* from *folding,* marking the shift to a view of digital architecture as a break from past architectures because of the generative processes allowed by topology and the algorithm, which overturn

500-year-old notational, linear architectural methodologies (Alberti's). Carpo claims the new architectural process to be *non-projectional*, a move which implies significant changes in the role of the architect. In this book Carpo does not include a discussion of biodigital techniques in architecture, despite their having been in operation since the early 90s. I find his historical account an important contribution to a field saturated with technical and instrumental accounts focusing on computation. His narration of digital architecture as novel on grounds of a shift to non-modern and non-projectional methodologies, however, is made while remaining within the modern convention of subjectivity boundaries. This, coupled with a lesser emphasis on digital architectural methodologies themselves and a reliance on the narratives as they are told by mainly American digital architects, stop him short of accounting for post-humanity as an ontological condition in need of theorization. This is, however, a break from a previous narration dating from 2004 – 'Ten Years of Folding', which cemented the moment of conception of a new paradigm of digital architecture encapsulated in the promise of *Folding*, which although inspired by Deleuze's *the Fold,* is still very much grounded in modern/ human – epistemologically as well as ontologically, theorized by Carpo as a new continuous style, replacing deconstructivism's angularity. Carpo's latest theorisation of the field is a 20-year retrospective published as an Architectural Design Reader, entitled *The Digital Turn in Architecture 1992–2012*, in which he reflects on the field in terms of mutual characteristics stemming from 'Postmodernism'. 'System theory', 'complexity science' and 'self-organising system' are cited as part of this tradition that he attributes to early cybernetics, framed as introducing 'non-linear' and 'emergence' architectural methodologies. Carpo's account of the digital discourse in architecture expands therefore to reflect all methodologies and branches operating under the *digital* umbrella (including biodigital design), these are then being attributed to the 'fuzzy ways' computers seem to work (Carpo 2013, 10–11).

Frédéric Migayrou is another example of a prolific historian of digital architecture, immersed in continental art and architectural history as well as in the history of science and mathematics. His main contribution to English-

speaking scholarship stems from his work as a curator of architecture at the Georges Pompidou Centre in Paris, as well as being the founder of the digital architecture curating platform known as *ArchiLab* – in the form of exhibitions and exhibition catalogues, as well as in lectures, his written work has nevertheless not on the whole been translated from his native French. Migayrou's curation of digital architecture spans a decade, marked by the 2003–04 exhibition *Non-Standard Architecture*, a theorization of digital architecture removed from framing with the American scene in digital architecture (as captured by Carpo in the same year). Migayrou views digital architecture as continuing a trajectory of twentieth-century topological experimentation in architecture of mathematizing/ calculating space, which he posits in sharp contrast to the dominant formal approaches in architecture. Deleuze plays only a small part in his narrative. His historical account is important in tracing a counter narrative to Carpo's one, while still taking part in the same trajectory of theorizing digital architecture as a break from modernity and therefore as a project replacing the centrality of the architect as operating formal architectural methodologies. In 2013, Migayrou replaces the *non-standard*, as the underpinning of a new architectural paradigm, with a new overarching narrative for digital architecture – *Naturalising architecture*, the outcome of an ArchiLab exhibition curated with Marie-Ange Brayer at the FRAC Institute, Orléans. This exhibition and the monograph that followed trace a new digital narrative, that of material and generative architecture of biodigital *emergence*. *Non-standard* is replaced by biodigital *emergence* as the new methodology and narrative of novelty. In both these cases, the breadth of architectural precedence presented overshadows a rigorous account of the mechanisms themselves, which, as is the case with Carpo, does not distance itself enough from the objects of study.

Greg Lynn wears two hats, those of historian/ theorist as well as architect. As an architectural historian, he is responsible for the moment of digital architecture's 'birth' – at least in official documents. Lynn is responsible for introducing Deleuze's *The Fold* to a wide architectural audience when, as a guest editor of *Folding in Architecture*, he included its first chapter in the publication, and therefore it is important to locate Lynn in relation to Deleuze. I refer to him on

his own narration of the shift to the digital and for an investigation on how he frames Deleuze's roll in this shift. In his *Architectural Curvilinearity, The Folded, the Pliant and the Supple* (1993), Lynn on the one hand acknowledges Deleuze's contribution to the field in terms of articulating a non-dualist methodology but, on the other, understands *folding* as a project of continuity, which he rearticulates in his introduction to the 2004 reprint of *Folding in Architecture*.

I refer to Kostas Terzidis's *Algorithmic Architecture* (2006) for a technical-historical account rooted in the script, in the algorithm, as the main reason for novelty in digital architecture. Terzidis claims, as does Carpo in his 2011 book, that novelty in digital architecture originates in the algorithm because of a 'post-humanist' logic which it has the capacity to instil in architecture (Terzidis 2006, 55), as that which is unplanned and unforeseeable. I find his position unusual among his peers in that Terzidis understands the significance of losing human control in order to maximize the algorithm's capacity. He nevertheless then harnesses the algorithmic otherness back to human intellect as a form of extension.

Mark Burry's *Scripting Cultures: Architectural Design and Programming* (2010) takes a different approach to digital architecture, while relating its novelty to a tradition of materialist experiments in architecture creating curvature architecture that he seeks to mathematize (especially Gaudi's), as well as to development in computation and as a break from humanist and modernist architecture.

Another architectural historian engaged with digital architecture is Antoine Picon. Picon's analysis of novelty in digital architecture, *Digital Culture in Architecture: An Introduction for the Design Professions* (2010) is understood on an instrumental level as part of a development in computation that has affected architecture since the 1960s, as another evolutionary technological stage. He accepts other influences, and acknowledges Deleuze's conceptual contribution only at the margins.

An example of an account of novelty investigation in digital architecture comes from outside the field, from digital culture studies, through the writings of

Luciana Parisi who investigates the algorithm as the main catalyst of change in the digital world of architectural production. In her 2013 book *Contagious Architecture,* the algorithm is already spatiotemporality rather than a tool. Beyond the technical definition of the algorithm as a procedure, that involves code and coder, Parisi's account of the algorithm or, more accurately, the digital algorithm, is materialized, in a manner that expands on the common understanding of the algorithm as an operation, in the control of its creator, or in the domain of a generative computational environment; for her the algorithm occupies a spatiotemporality that is contaminated with random and non-legible procedures, which render the potentiality of novelty. Although Parisi brings to the fore rich computational theory, her theory is less embedded in the architecturally specific methodologies and mechanisms.

The historical and theoretical discourse of digital architecture is lacking in the specificity of past and current tools, mechanisms and methodologies of the discourse that support the widespread claim for a novel postmodern digital paradigm.

Mathematical History and Parametrics Sources

The history of the mathematics underpinning digital architecture is told in various architectural publications with the prominent ones being Jane and Mark Burry's *The New Mathematics of Architecture* (2010) and in *The Mathematics of Space* (2011), a special Architectural Design publication guest-edited by George Legendre. Legendre's compilation is an open call to digital architects to return to mathematics and discard commercial digital software that suppresses the mathematical mechanism. This publication's historical reach is limited and is concerned mainly with the practicality of parametric functions. Where mathematical history is being considered, as in the case of the mathematical historian Amy Dahan-Dalmedico, her account nevertheless outlines a brief history of the mathematics of space whereby she creates a straight line from Descartes to the nineteenth century, bypassing entirely the genealogy of the differential calculus that goes back to Leibniz. While Jane and Mark Burry's mathematical account is also a practical one, in the limited case where they give a historical account of topology, the system that underpins digital computation in

architecture, they attribute it directly to Deleuze's concepts (promoting spatial continuity). However, their focus is not on the histories of this mathematics, but to account for the relationship between the new mathematics and digital architecture since the mid-1990s.

The overall mathematical account of digital architecture being framed in a practical manner suppresses the importance of the ontological aspect of such mathematics. This disembedded account theorizes mathematics as a neutral and natural epistemological tool.

In search of a mathematical underpinning of topology, I expose a genealogy that leads back to that of Leibniz. The first stop is Deleuze's writings where he gives an account of Leibniz's immediate disciples and traces the near extinction of the infinitesimal idea in mathematics and its rediscovery in the nineteenth century by Gauss and Riemann and then by Poincaré. Deleuze briefly discusses Robinson's development of non-standard analysis in mathematics in the 1960s. This mathematical history is told mainly in *The Fold* (2006 [1988]). For the detailed account of the mathematical-philosophical aspect of the differential calculus, I turn to transcripts from Deleuze's seminar on Leibniz known as the *Vincennes Session* (April–May 1980).

I also refer to the philosopher Simon Duffy's book *Deleuze and the History of Mathematics: In Defense of the 'New'* (2013), in which the author illuminates and expands not only on the mathematics Deleuze refers to in the construction of his concepts, but also on the ontological aspect of these mathematics. Duffy's breadth of knowledge in mathematics and Deleuze studies is remarkable, and so I turn to him for an excellent cross-section of the differential calculus in Deleuze's texts. For a more recent mathematical history, I refer to Manuel DeLanda's 2002 *Intensive Science and Virtual Philosophy,* DeLanda being recognized as introducing the complexity of Deleuze's mathematical thought to digital architecture. I depart from his analysis on the grounds of Deleuze's ontology, which I claim to be suppressed by DeLanda's mathematical account. I am also aided by Boyer and Merzbach's 2011, *A History of Mathematics*.

For an analysis of Grasshopper, the digital architectural software, I turn to the open-source literature found on the Grasshopper website, especially to tutorials and to technical literature. I also refer to a lecture by Grasshopper's inventor and developer David Rutten, *Computing Architectural Concepts*, given at the Architectural Association (2010). I am also aided by Arturo Tedeschi's book, *Parametric Architecture with Grasshopper* (2011).

Biodigital Architecture and History Sources

The architectural interest in biodigital practice does not have a specific historical and theoretical body of literature. The majority of available literature comes in the form of technical accounts, monographs or magazines. I refer here mainly to Weinstock, Menges and Hensel's 2010 *Emergent Technologies and Design: Towards a Biological Paradigm for Architecture*, in which the authors account for their Architectural Association's research group research and projects; this is a good source for an overall understanding of their approach, but it lacks detailed methodology and insight into the make-up of their biomimetic digital tools. Achim Menges, in his independent work, gives a detailed account of his biomimetic methodology, although it excludes any insight into the computational level. I refer here to an Architectural Design spatial issue, guest-edited by Menges in 2015: *Material Synthesis, Fusing the Physical and the Computational*.

For an overall appreciation of the biomimetic underpinning of digital production, that of genetic algorithms (GAs), I turned to non-architectural sources – to the work of the computer scientist Melanie Mitchell in her *An Introduction to Genetic Algorithms* (2001) and *Complexity: A Guided Tour* (2011) that illuminate the translation of evolutionary processes to computation. As a former student of John Holland, she also shows the history leading to the development of genetic algorithms.

For an alternative concept of evolution, I turn to Elizabeth Grosz's *Becoming Undone: Darwinian Reflections on Life, Politics, and Art* (2011) which offers an alternative to the reductive and deterministic evolutionary theory embedded in genetic algorithms. This alternative challenges the centrality of selection by fitness as the main determination process in biology. I refer especially to her

work on Jakob von Uexküll's notion of *umwelt,* which articulates an active and embodied mechanism of receptivity and differentiation. On the incorporation of *umwelt* as part of Deleuze's development of a non-human register, I turn to Stephen Loo and Undine Selbach's *Insects and Other Minute Perceptions in the Baroque House* (2015).

I also turn to the philosopher Keith Ansell-Pearson's book *Germinal Life: The Difference and Repetition of Deleuze* (1999) for an excellent cross-section on the alternative notion of life that inhabits Deleuze's work, from early Bergsonian influences and the articulation of *creative evolution* to the later *involution* as his concept of autopoiesis shifts in his work with Guattari and their adoption of the *machinic phylum.* On the machinic phylum I turn directly to Deleuze and Guattari in *A Thousand Plateaus* (448–52).

Ethical Digital Discourse/ Critique

The critique of digital discourse takes many forms, including feminist, Deleuzian and political. All point to an ethical lacuna operating in the discourse, but each articulates it from a different angle. In this thesis, I refer to critique in a cross-section that is suggested in all chapters, although it is the last chapter that is dedicated to it.

In cartography 1, narrative 1, I refer to two feminist critiques. The first is that of Claire Robinson, whose text concludes both editions of *Folding in Architecture* (1993, 2004). In 'In The Material Fold: Towards a Variable Narrative of Anomalous Topologies', Robinson voices an early concern over the amalgamation of Deleuze's thought with formal practices in the early days of digital discourse. She suggests an embodied alternative conceptualization of René Thom's catastrophe theory, which is a unique voice. Amidst the predominantly *continuous* interpretation of *The Fold* translated through the catastrophe theory model, Robinson stresses the points of singularity as expressing otherness. Karen Burns points to the fact that Robinson's voice disappears from the narrative, as there is no mention of her text in the newly contributed text to the 2004 reprint, namely Carpo's historical overview and Lynn's introduction. Burns points to this anecdote in her 2013 *Becomings:*

Architecture, Feminism, Deleuze – Before and After the Fold where she generally views the 'encounter' between Deleuze's *The Fold* and digital architecture's discourse as resulting in a reduction of Deleuze's complexity into a formal idea. Her paper appears in a much called-for book entitled *Deleuze and Architecture* (2013), co-edited by Hélène Frichot and Stephen Loo, who provide a comprehensive overview on the relations forming between Deleuze and architectural discourse throughout the 80s and 90s, but not necessarily from a digital point of view. In the introduction, Frichot and Loo critique the instrumental adaptation of Deleuze's work within architectural circles. Another example of the same claim in the book is made in Marko Jobst's text *Why Deleuze? Why Architecture?* in which he argues that 'architects tended to focus their attention on the literal and physical folding – the idea of formal continuity' (Jobst 2013, 67),[18] referring directly to Lynn. The same criticism is voiced in another of Hélène Frichot's texts (2012), *The Forgetting of the Ethics of Immanence*, in which she discusses biodigital practices in particular. Although I share their observation on the reduction of Deleuze to enable majoritarian practices in architecture, both through the use of what is known as *popular* culture in architecture in the late nineties and in current architectural practices, I nevertheless point to a more nuanced narrative.

As I show in cartography 1, the first generation of digital architects acknowledged Deleuze's post-human ontology as a means of shaking architecture out of dualist and humanist practices. The reductionist process of forgetfulness/ omission/ misinterpretation occurred at a later stage, in the narration period of the 2010s. And while I join Frichot and others in their observation on the majoritarian application of Deleuze's work, I do, however, recognize two lingering gaps in her critique, and it is here that I see my contribution to the field of research. I suggest that Frichot's analysis could benefit from a similar immanent quality to that which she finds missing in the practices themselves – and by that I mean that she still operates very much in the culture of critique, which suggests a falling back to the culture of dualism and

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[18] Jobst quotes from Mallgrave and Goodman, *An Introduction to Architectural Theory 1968 to the Present,* (London: Wiley-Blackwell: 2011), 164.

binary that she disputes. The second gap that I would like to point to is Frichot's criteria of analysis, which are lacking on the grounds of technical discussion.

An upfront political critique specifically targeted at parametricism is voiced in the 2015 book, *The Politics of Parametricism: Digital Technologies in Architecture*, co-edited by Matthew Poole and Manuel Shvartzberg. This book brings together a wide range of approaches; I refer to two feminist texts in my search for other voices in the discourse, which stress an embodied critique. The first is a feminist critique on the deterministic digital approach to evolution in genetic algorithms, voiced by Christina Cogdell in *Breeding Ideologies: Parametricism and Biological Architecture* which I refer to in cartography 2, part 2, and the second is Peg Rawes' *Spinoza's Geometric and Ecological Ratios* (2015*)*, which develops embodied, relational alternatives to parametricism through a reworking of the Spinozian notion of ratios.

Deleuze's writings are of course a main primary source for this thesis. I turn to *Difference and Repetition* (2004 [1968]) for an early articulation of Deleuze's philosophy of difference, already containing references to Leibniz's mathematical mechanism and metaphysical aspects. However, in this book, the focus in the definition of difference is in relation to Western thought in general. In *The Fold* (2006 [1988]) Deleuze goes back to Leibniz, but in this later publication Leibniz is immersed in his own milieu, the Baroque. It is here that Deleuze expands on both systems that he draws upon Leibniz for – the mathematical (differential calculus) and the philosophical world and principles that this mathematics occupy, namely, an infinitesimal capacity for individuation, infinite as per reliance on bodily existence. These concepts are well articulated in the Seminars Deleuze gave in 1980 in Vincennes, Paris, to which I refer in cartography 2, part 2. In *The Fold* this system holds a specific social and political aspect, which is the main theme in his earlier work with Guattari, *A Thousand Plateaus*. I refer to this work for their articulation of minoritarian and majoritarian genealogies, especially in regard to transposition in cartography 2, part 2, and in the last chapter, where I conclude my thesis by developing an alternative nomadic concept of engaging with the machinic phylum, which draws me to another of Deleuze and Guattari's concepts: that of the *artisan*, which they

develop in *A Thousand Plateaus* (451–6).[19] Deleuze address the need to reconceptualize human subjectivity as part of his nomadic thought – constructed away from Guattari in two examples, in his rearticulation of Leibniz's infinitesimal calculus as well as in a concept of *Umwelt,* which Deleuze draws upon.

In my last chapter, I develop an alternative conception of imperception mechanism, and the notion of affectual relationship as an embodied and inter-subjective system of relating that has a distinct socio-political register. I refer back to Deleuze and Guattari in *A Thousand Plateaus* (2004 [1980], 288) for their articulation of affect as a non-dualist, non-representational form of 'interaction' that defines a social or any other material system. I refer to Brian Massumi's *Politics of Affect* (2015) for a reworking of Deleuze's understanding of its operation, while Massumi emphasizes the embodied and traceable aspect of affect and its mode of perception in *microperception* (Massumi 2015, 53). Massumi position the interest in *affect* as an embodied alternative mode of operation in our current advanced capitalist society.

In my search for architectural digital precedence that incorporates embedded and affective sensitivity, I refer to Françoise Roche and Stéphanie Lavaux's project *I have heard about …* (2004–06), in which the authors articulate a post-human ecological and ethical thinking.

Rosi Braidotti's work traverses the entire thesis. I draw on her work as a thematic source, specifically on her nomadic reconstruction of the subject as a nonunitary, yet situated position, which informs and frames my critique of digital discourse's disembedded and disembodied practice.[20] Nonunitary subjectivity informs the theorization of the *artisan* in digital architectural terms, which I suggest in the last chapter (Braidotti 2006, 2011). My overall methodological approach to this research is also informed by Braidotti's nomadic theory and her emphasis on the *politics of affirmation*, which entails a

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[19] See *Newness/ Difference* in this introduction for an elaboration on what concepts I draw on in Deleuze and Guattari's work.

[20] I show that nonunitary subjectivity is implied in Deleuze's own articulation of nomadic thought – constructed away from Guattari in two examples, in his re-articulation of Leibniz's infinitesimal calculus as well as in a concept of *umwelt,* which Deleuze draws upon.

mode of relationality that is embodied, embedded, and post-representative-relational and affective. This approach entails specific methodological tools that are capable of navigating in a dynamic, cross-disciplinary and situated way; I refer here to cartographing and transpositions as my main tools of engagement, which I present separately shortly. I draw mainly on *Nomadic Theory: The portable Rosi Braidotti* (2011) for a detailed account of the context, methodologies and main mechanisms of nomadic theory, especially in relation to her posthuman figuration – that of a nonunitary subjectivity. I refer to *Patterns of Dissonance* (1991) for a general positioning of the correspondence between feminist scholarship and Deleuze's radical immanence on questions of subjectivity, and to *Transpositions* (2006) for Braidotti's theorization of transversal nomadic methodologies as means of affirmative resistance.

Another source of inspiration for an articulation of nonunitary subjectivity is Sadie Plant's feminist and nomadic *Zeros and Ones* (1988), which positions the pre-digital Ada Lovelace as a figuration of *becoming imperceptible* (Plant is inspired by Irigaray's not-one). Plant account itself is an example to nomadic methodology that traverses temporalities and disciplines. Again, this source is external to the discussion of digital architecture, although immersed in early digital culture.

Relating and referring to primary sources from a wide range of disciplines attests to my cartographical methodology. It is also an indication of the lack of a specific literature of digital architecture approached from a nomadic point of view. The recent politically aware publications that I have indicated attest to the need for an ethical repositioning of digital architecture; I nevertheless argue that, in order for a qualitative difference to be registered, we need to depart from the dualistic models elaborated upon in digital architecture. This thesis therefore contributes to three fields of research: the first is that of architectural histories, theories and critique of digital architecture; the second is in the context of Deleuze studies; and the third is feminist nomadic theory.

I now proceed to discuss my methodology and to show how it differs from current approaches in architectural histories, theories and critique. I see this

methodology as helpful in both accounting for the discursive position and in resisting it.

Methodologies

Departure Point, Methodological Vacuum in Accounting for Digital Architecture

Pre-digital architectural notational, linear and projective methodologies consisted of plans, elevations, perspective drawings and details, and in some cases other visual methods (such as collages and drawings), culminating in 3D models. These were not only the design conventions; they were the objects of study, the professional reference material for architectural historians and theoreticians. In a post-notational, post-representational architectural world, what is the new materiality of the architectural historian and critic? Excluded from going any deeper to analyze the digital processes and systems, the architectural historian relies on the architect's narratives (as, I argue, is the case with Carpo 2004, 2011); or approach the new architecture while using old methodologies (Picon 2010), collapsing the richness of the design process into a formal top layer barred from accessing the meta-level of these design processes. This influences the lack of criteria for debate, or the prevalence of formal or intuitive criteria for relating to the digital. In these murky waters, regimes of sameness flourish. It is here that I posit the need for nomadic methodology with its transversal capacity to link these often-distinct fields of knowledge that underpin the digital methodologies in architecture; such a methodology provides alternative modes of relating to the discourse.

The above literature review demonstrates the difficulty in accounting for the changed architectural paradigm. In the couple of cases where architectural historians possess technical knowledge, as is the case with Terzidis and Migayrou, their histories are grounded by their overall humanist and disembodied ontology. Another aspect is revealed by listing the main historians of digital architecture, showing a particular demographic; the official historians of digital architecture fit the phallogocentric ideal profile – that is to say, Mario

Carpo, Antoine Picon, Mark Burry and Frédéric Migayrou are all middle-aged, white and immersed in the academic and practical establishment with architectural/ engineering/ mathematical educational backgrounds.[21]

Before I move on to discuss Braidotti's articulation of a new methodological tradition that addresses these convoluted realities, not by shying away from them nor by applying humanist tools but by applying an old-new relationality, I would like to locate her contribution to critical theory as part of a nomadic tradition.

Nomadic Methodologies Towards Politics of Affirmation

Nomadology is attributed to Deleuze and Guattari's co-writing. The term is elaborated upon in *A Thousand Plateaus* as the political figuration of the rhizome, and as an alternative to major state science (401–7). Nomad, therefore, 'is a name for absolute deterritorialisation' (Bonta and Protevi 2004, 118–9). In Claire Colebrook's glossary to her textbook *Understanding Deleuze* (2002), nomadology is explained separately from *A Thousand Plateaus* and the geophilosophy it unfolds, and is instead explained simply in terms of non-dualist epistemology:

> Most of western thought has tended to operate from a fixed or grounded position: either the position of man or the subject of humanity. Even beyond the human realm, life works through fixed perceptions to produce a perceiver and perceived, an inside and an outside. The aim of nomadology is to free thought from a fixed point of view or position of judgement. Nomadology allows thought to wander, to move beyond any recognised ground or home, to create new territories (Colebrook 2002, xxvii).

Braidotti, similarly to Colebrook, extracts the term from its geopolitical context as she explains: 'Nomadism is not an anthropological metaphor. It is a figuration that emphasises dynamic, relational and territorialized, yet not nationalized. An affirmative deconstruction that reflects on becoming as an ongoing thing as becoming imperceptible' (Braidotti 2012). Nomadism, therefore, is a mode of

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[21] I elaborate on Mario Carpo's majoritarian role as the official narrator of digital architecture in Cartography 1.

conceptualization that 'instils movement and mobility at the heart of thinking' (Braidotti 2011, 1). Nomadism as a branch of critical thought with which Braidotti engages is outlined in two publications from Columbia University Press: *Nomadic Subject: Embodiment and Sexual Difference in Contemporary Feminist Theory* (2011) and *Nomadic Theory: The Portable Rosi Braidotti* (2011), where nomadic thinking is stressed as an alternative to humanist, cognitive, universal and disembodied thinking.

Braidotti positions nomadic thought as part of two major lineages – materialist and feminist. She recently re-articulated the materialist lineage of this genealogy in her lecture *Vectors of Affirmation* (London 2015) where she framed her own interest in materialist thinking with a long tradition of enfleshed, French philosophy that in the mid-twentieth century was associated with Gaston Bachelard (1884–1962), Georges Canguilhem (1904–95), Michel Foucault (1926–84), Michel Serres (born 1930) and Deleuze.[22] 'This is the great French tradition – the radical immanence of their philosophy of science – their understanding that matter is vital' (Braidotti 2015). This line goes all the way back to the eighteenth century: 'to Diderot, to the enchanted materialism of the French, it assumes the continuum of the flesh matter that is relational, embedded, embodied, affective' (ibid.).

This French connection is the link between post-structuralist and feminist embodied thinking of difference:

> the feminist philosopher Luce Irigaray (1985) addresses, notably her praise of the 'machinic fluids' against the fixity and lethal inertia of conceptual thinking (also known as the phallocentric logic of masculine self-representation). Gilles Deleuze (1962, 1968) also takes up this challenge by loosening the conceptual ties that have kept philosophy fastened on some semireligiously held beliefs about reason, logos, the metaphysics of presence, and the logic of the Same (also known as molar, sedentary, majority) (Braidotti 2011, 15).

This lineage connects Braidotti to feminist theory and the methodology that it brings: the grounded epistemology which in the 1980s was called the *politics of*

[22] Braidotti reminds us in this lecture that 'Foucault was trained by Canguilhem; Deleuze and Michel Serres were both supervised by Bachelard' (Braidotti 2015).

location, and from the 90s up to the present day is called *situating knowledge*.
Location, Braidotti further explains, 'is a multiple timeframe', which consists of
'memories, time lines that are part of our assemblages, events, things that we
forgot to forget' (Braidotti 2015). The politics of location/ situating/ the
insistence on embedding and embodying is mentioned by Braidotti as the legacy
of her feminist genealogy, of equal standing with non-dualist methodology.

This enfleshed mode of thought is both a critique and a creative way forward. It
forms an alternative to modernist humanist thinking: 'The embodiment of the
mind and the embrainment of the body (Marks 1998) are a more apt formulation
for nomadic thought than Cartesian or other forms of dualism' (Braidotti 2011,
2). Nomadism, claims Braidotti,

> stresses the idea of embodiment and the embodied and embedded
> material structure of what is commonly called thinking. It is a materialism
> of the flesh that unifies mind and body in a new approach that blurs all
> boundaries (ibid.).

As she further elaborates on the thinking and creative tools of the nomadic
alternative:

> the space of nomadic thinking is framed by perceptions, concepts, and
> imaginings that cannot be reduced to human, rational consciousness. In a
> vitalist materialist way, nomadic thought invests all that lives, even
> inorganic matter, with the power of consciousness in the sense of self-
> affection. Not only does consciousness not coincide with mere rationality,
> but it is not even the prerogative of humans. The emphasis on affect and
> extended consciousness, however, is not the same as the Freudian
> unconscious (ibid.).[23]

Braidotti argues that social and cultural critique does not equate with the
dialectical and confrontational mode, but rather:

> It requires a robust praxis of collective engagement with the specific
> conditions of our times – for instance, the proliferation of quantitative
> differences and erasure of qualitative shifts in ethical and political
> accountability. Furthermore, *nomadic thought engages with the present*

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[23] Braidotti further explains her location in regard to psychoanalysis: 'Nomadic thought
rejects the psychoanalytic idea of repression and negative definition of desire as lack inherited
from Hegelian dialectics, it borrows instead from Spinoza a positive notion of desire as an
ontological force of becoming.' Braidotti, *Nomadic Theory,* 2.

not oppositionally but rather affirmatively and does so not out of acquiescence but rather out of pragmatic conviction that the conditions that engender qualitative shifts will not emerge dialectically from a direct and violent confrontation with the present. They can only be actualised as praxis from conditions that are not there yet: *they are virtual, that is to say, they need to be counteractualised, created, and brought about in a collective effort* (ibid., 19, my emphasis).

How is this done? The answer suggested is by delinking the basic components of the liberal view.

> Nomadic thought accomplishes a double aim. The first is genealogical or cartographic; it turns to be the sources of European critical theory in an inspirational manner. The second is conceptual: it seeks for sustainable alternatives and affirmative modes of engagement in the present by linking the act of thinking to the creation of new concepts and critique to creation [...]
>
> Nomadic theory strikes its own note in this debate on behalf of the affirmative force of nonhuman life – zoe – and its posthuman potential (ibid., 7–8).

Nomadic thought brings with it a set of methodologies that relate through insisting on embodying and embedding a discourse in an affirmative, that is to say, non-dialectical way. In the next section I discuss in detail the first methodology I borrow from Braidotti – *cartography.*

On Cartographing

Cartography is a methodology that refers back to Foucault as a means to traverse the power play that defines subjectivity:

> A cartography is a theoretically based and politically informed reading of the process of power relations. It fulfils the function of providing both exegetical tools and creative theoretical alternatives, so as to assess the impact of material and discursive conditions upon our embodied and embedded subjectivity (Braidotti 2011, 4).

Cartographing is seen as an apt methodology to account for the complexities of advanced capitalism, accounting for flux, movement, change, metamorphosis and dynamism. It is for this reason that Braidotti proposes cartography as the appropriate navigational tool, as a means to embody the 'various power

differences between distinct forms, categories, and practices of movement for both human and non-human mobile units […] Telling the difference among these differences is a key question', she further explains (ibid., 11). It is this insistence on concepts of movement, non-fixity and durational processes that sets cartography as an alternative to modernist and postmodernist techniques of classification. The answer is a politics of location; Braidotti stresses that cartography is not necessarily a means of replacing humanist methodology, but is, rather, an alternative means of grounding,

> The counter method starts from the politics of locations. This is both a strategy and a method based on politically informed cartographies of one position, starting not from gender alone, but from the bundle of interrelated social relations. The practice of politics of locations rests on notions like experience, situatedness, accountability and transversal alliances (Braidotti 2006, 92).

'The aim to construct intellectually mobile concepts requires an ethics of differential coding for the various modes and forms of mobility' (Braidotti 2011, 10). Cartography is therefore a methodology aimed at challenging and debasing Western humanist traditions and questioning late capitalism's core values, exposing its moral shortcomings as well as the shortcomings of the system of analysis that Western liberalism centres – though not with the purpose of injecting alternative morals into the system, but in order to rethink the need for a system altogether:

> it is not a question of establishing new methodological or political hierarchies of values, so as to apportion respective merits and deficits. It is not a matter of mutually incompatible systems and options, but rather of grounding the different ethical values concretely, historically and geopolitically, so as to be able to account for them. These situated cartographies provide the material dialogical exchanges within the horizon of diversity and not under the empire of Sameness (ibid., 93).

Braidotti uses practices of cartography to map certain areas of human activity along axes of empirical difference that have been influenced by a convergence of biotechnologies (especially in the field of genetic research and artificial enhancements) with information technologies and their globalized by-products. These areas of debate may have been well mapped before, but not only were

previous accounts insufficient by Western humanist standards – either because of poor mapping and poor resolution that accounted only for contour lines, made in haste and therefore missing important details of a given area of conflict, or because there was a slight move, a shift in the geological plates, that was not captured before Braidotti's machineries were put to use – but also, claims Braidotti, the in-between situations she captures in her cartography escaped past analysis because she uses different tools of analysis.

Moreover, 'optical machinery', which is the 'standard cartography machinery', is not equipped to render the neglected aspects of these scenarios.[24] Braidotti is able to reach these corners of negligence and darkness in the Western master narratives not because she uses better lenses, or because her technique is superior, but either because her lenses are installed on completely different types of machine or because she uses other tools that do not centre on optical clarity, which is uni-focal. As alternative techniques, Braidotti suggests a variety of practices, most of which involve as a first stage zooming in – that is to say, analyzing the micropolitics as a means of grounding. This requires the use of techniques borrowed from other disciplines. To persist with the cartography metaphor, it requires some local geology and even crystallography; dissolving the boundaries between inside and outside, centre and periphery, and therefore bringing into question the role of dichotomized analysis. Also, and beyond resolution, Braidotti is not interested in producing a static map, nor does she believe in a one-way analysis, but rather she is constantly looking for areas of transposition, of feedback, of mutations and crossovers between subject and object. This leads her to use temporal factors that may change her map temporarily: the tides, the winds, the floods, the termites, the moles; the immediate milieu of a particular area. Such techniques bring Braidotti closer to her other goal – that of exposing the insufficiency of central theories supporting regimes of power at the basis of the image of thought.

Braidotti reminds us of Haraway's definition of location:

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[24] See Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective", *Feminist Studies* 14 (1988): 581–90. For her critique on the place of practices of vision in Western culture, and its insufficiency to account for complexity.

> Location is not a listing of adjectives or assigning of labels such as race, sex and class. Location is not the concrete to the abstract of decontextualization. Location is always partial, always finite, always fraught play of foreground and background, text and context that constitutes critical enquiry. Above all, location is not self-evident or transparent. Location is also partial in the sense of being for some worlds and not others (Haraway 1997, 37) in (Braidotti 2006, 92–93).

Braidotti also reminds us that such practices, such adherence to the politics of location are, by definition of their processes, materialist and immanent:

> As a method it combines: self-reflexivity and accountability with ways of enlarging scientific objectivity. It involves dialogical confrontation with others, in a mixture of affectivity/ involvement and objectivity/ distance, which needs to be balanced in a critical manner. Such a methodology can only be transdisciplinary and thus scientifically impure (ibid., 93).

The methodological insufficiency of current digital, theoretical and critical literature to account for difference production in the contexts of digital discourse leads me towards cartography as the main practice of this thesis. I propose to undertake cartography as a methodology, through focusing on a variety of literature types, including the narratives and historiographies of novelty in the digital, excavated from digital architecture's recent history, theory and criticism, as well as digital architecture methodologies as they branch to form two distinct fields – those of topological and biodigital architecture. In relation to discussion on computation and design methodologies, I refer to technical and scientific literature in mathematics and computation as well as looking into the computational world, through mathematics and software. By engaging with digital architecture on multiple levels, breaking down the narratives into the respective disciplines that feed them, by approaching the scientific ontologically, by applying location, attaching genealogies to these distinct disciplines, I am better able to account for the convoluted state of the discourse and uncover the narratives of complexity and novelty as operating on the surface only – that is to say, without differentiating. However, cartography is the analytical aspect of a creative intellectual process. The way to achieve qualitative differentiation is through a creative practice. One of these practices is *transposition.* How can one account for non-fixity and location in the same breath? In order to explain this

counterintuitive coupling, we need to consider another aspect of Braidotti's theory, that of the subject position of nomadic theory, which is the key to understanding why I deem Braidotti's reconceptualization of radical immanence an important political conceptualization. This breaks methodology-content conventions, which is why I locate the discussion on nonunitary subjectivity below, in the thematic part of this introduction.[25]

On Transpositions

Nomadic theory introduces transpositions, to account for the rate and intensity of social and cultural mutation, and to inject new dynamism through the reintroduction of temporality to critical thinking:

> Nomadic methodologies work by empowering creative alternatives. This philosophical creativity operates a shift of paradigm toward a positive appraisal of difference, multiplicity, and complexity not as an end in themselves but as steps in a process of recomposition of the coordinates of subjectivity (Braidotti 2011, 232).

Transposition is therefore seen as a dynamic and affirmative methodology that is rooted in careful cartographies of power patterns and relations while highlighting the cracks and holes in a system that is never hermetic. This porosity of the system then allows for a reconceptualization of the power flow and its redirection towards the nomadic subject position.

> This results in a critique of representational regimes that focus especially on the dominant as the expression of a white, masculine, adult, heterosexual, urban-dwelling, property-owning subject. Deleuze and Guattari label this dominant subject as the Majority, or the Molar formation [...]. For nomadic thought, this replication of sameness is

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[25] This convention further attests to the impossibility of demarcating epistemology from ontology. Karen Barad names this approach '*ethico-onto-epistemological* matter', and she explains: 'It underlines the fact that knowing is a direct material engagement, a cutting together-apart, where cuts do violence but also open up and rework the agential conditions of possibility. There is not this knowing from a distance. Instead there is a separation of subject and object, there is an engagement of subject and object, there is an entanglement of subject and object, which is called "phenomenon." *Objectivity instead of being about offering an undistorted mirror image of the world, is about accountability to marks on bodies, and responsibility to the entanglement of which we are a part'.* See Rick Dolphijn and Iris van der Tuin, "Interview with Karen Barad", in *New Materialism: Interviews & Cartographies*, eds. Rick Dolphijn and Iris van der Tuin (Ann Arbor: Open Humanities Press, 2012), 52.

counteracted by creative efforts aimed at activating the positivity of differences as affirmative praxis [...].

Resting on the assumption of a fundamental and necessary unity between subject and object, the theory of transpositions offers a contemplative and creative stance that respects the visible and hidden complexities of the very phenomena it attempts to study. This makes it a paradigmatic model for scientific knowledge as whole, particularly feminist epistemologies, notably the critique of dualistic splits (Braidotti 2006, 5).

The relationship between critique and creation is central to nomadic thought, which positions its approach in terms of affirmative interventions that is above all non-dualist in its relations to the context of its research. It achieves this by interdisciplinary and multi-angled approach to research. It draws on genetics and music as two genealogical sources; from both, it maps creation that operates on a 'transversal transfer of codes', leaping from one field to another. In music, such a methodology articulates itself by variations and shifts of scale in a 'discontinuous but harmonious pattern', 'created as an in-between space of zigzagging and crossing' (ibid.). This genealogy stresses non-linearity and the importance of negative spaces that are the thresholds for alternative perceptions not perceptible in the first place, but become so as means of derivation. Genetics is called upon for a similar non-linear process, that of genetic mutation, understood as 'the transferral of genetic information, which occurs in a non-linear manner, which is nonetheless neither random nor arbitrary'. Braidotti stresses the *notion of material embodiment* or the decisive role played by the organism in framing and affecting the rate and the frequency of the mutations. This is contrary to 'mainstream scientific vision that tends to define the gene as a steady entity that transmits fixed units of heredity in an autonomous and self-sufficient manner and genetic variation as random events' (ibid.), while relying on the work of Evelyn Fox Keller who demonstrates, through her reworking of the Nobel Prize-winning geneticist Barbara McClintock, that the process of genetic transposition is internally determined by the elements of the cell itself and thus is not prewritten in the gene, highlighting the role of material embodiment and the decisive role played by the organism in framing and affecting the rate and the frequency of the mutations. This is a process termed by McClintock 'jumping genes' (Braidotti 2011, 226–7). Both these fields stress an

affective and embodied notion of relationality to replace traditional static methodical approaches. 'These leaps are not to be understood merely in the quantitative mode of plural multiplications, but rather in the qualitative sense of complex multiplications' and more importantly, 'playing the positivity of difference as an ontological force and for setting up adequate frames of resonance for their specific rhythms of becoming' (ibid.).

An emphasis on movement is a central theme in nomadic theory, not only in the sense that our methodology needs to be modified to apply to the 'fast moving changes that do not wipe out the brutality of power relations, but in many ways intensify them' (ibid., 10–11). Amidst the fast mutating and contradictory globalized system, transpositions are seen as interventions: 'alternative interventions in the present contextual conditions' (ibid., 13). Braidotti expands on these cultural paradoxes as those between rising conservatism on the one hand and, on the other, a fascination with change and mutant and nonunitary others, attesting both to anxiety amidst the fast rate of the transformation of identities and to a 'poverty of our social imaginary to cope creatively with the ongoing transformations' (ibid.). The transdisciplinary and non-linearity of transpositions is a way of addressing these challenges in the production of new *figurations*. Figurations, explains Braidotti, do not equal a figurative way of thinking, 'but rather more materialistic mappings of situated, embedded and embodied positions [...] Figurations are ways of expressing different situated subject positions. A figuration renders the nonunitary image of a multi-layered subject' (ibid.). These figurations, though, should not be understood as a 'universal metaphor for the human or posthuman condition' (ibid., 14). This act of figuration traverses this thesis vertically, acquiring form as it differentiates from the humanist position by stressing embodied and relational practice to counter persisting humanist habits, as well as insisting on partial, non-fixed, nonunitary conceptualizations of subjectivity.[26]

Structure

The discussions in this thesis are arranged into three chapters; the first two are *cartographies* and the last one is a *transposition*, such a structure maintaining the

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[26] See Nonunitary subjectivity below.

relational and dynamic processes that allow for rigour of situating with the creative aspect of transposition. Cartography 1 is dedicated to the *narratives of digital architecture* and addresses three novelty narratives. This cartography situates the digital discourse and its narratives of novelty between two poles, humanist ontologies and post-humanist epistemologies. Cartography 2 relates to the practices and methodologies of digital architecture and is divided into two parts. Part 1 explores the *mathematical formation* underlying the tools and methodologies of digital production and the way this mathematics informs our current digital discourse through the prism of parametric discourse. Cartography 2, part 2, deals with *biodigital methodologies.* It brings to the surface the predominantly deterministic approach and tools underlying these architectures and also proposes a different engagement with practices of evolution and perception to inform a dialogue of subjectivity. Cartography 2, part 2, sets out a proposition of nomadic subjectivity in a digital context as an ethical alternative to the current, disembodied state of the discourse. The third chapter is a *transposition,* where nomadic digital methodology is proposed.

Chapter 1,

Cartography 1 – Novelty Narratives: from Folding to Scripting: towards non-representational algorithmic thinking

This cartography accounts for the historiography of digital discourse in architecture developed over the past two and a half decades and questions three novelty narratives: narrative 1 – *Folding*, narrative 2 – *Non-Standard,* narrative 3 – *The Algorithm.*

Narrative 1 – Folding, the first narrative, articulated by Mario Carpo (2004),[27] argues for 1993 as the inception moment of a digital era, and confirms the fractions of deconstructivism as well as concepts developed by Deleuze in *The Fold* (2006 [1988]) as inspiring a new architectural practice of formal *continuity* coined as *folding.* I show that this narrative not only misplaces Deleuze's

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[27] Greg Lynn, ed., *Folding in Architecture,* (Chichester: Wiley and Sons, 2004 [1993]).

concepts and reduces them to formal enquiries, a critique often made of this formative moment of encounter,[28] but also that Carpo's 2004 text misrepresents the spirit of the original 1993 *Folding in Architecture* by not conveying an inner tension expressed by the featured architects, such as Peter Eisenman, Jeffery Kipnis and Greg Lynn, that conflated non-dualist *ontologies* and formal *methodologies*.

Narrative 2 – *Non-Standard*. Following an exhibition at the Centre Georges Pompidou, Paris (2003–04), an alternative and competing with *Folding* narrative emerges. Framed by the exhibition curator Frédéric Migayrou, the new architectural paradigm calculates space while using topological mathematical models, rather than formally producing spatiality. This narrative places the novelty of the digital with a post-formal, mathematical practice. The mathematized architectural solution is praised for being 'rational' as opposed to the subjective formal space. Again, this is an example of the tension I mention above, of post-humanist epistemologies caged by humanist ones.

Narrative 3 – *The Algorithm. Algorithmic architecture* is the third digital narrative of novelty. It marks a shift towards a reliance on digital architectural platforms and tools not in existence in 1993. In this part, I turn to a computational-architectural theory by Kostas Terzidis (2006), and to a renewed historical-architectural theory by Mario Carpo (2011). Their algorithmic narratives maintain the same humanist/ post-humanist hybridity. On the one hand, Terzidis renders the capacity of the algorithm to transcend humanistic practices in architecture into post-humanist ones (Terzidis 2006, 55), while Carpo maintains that the algorithm replaces the humanist paradigm of the *identical* with a non-

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[28] The history of the encounter between Deleuze and architecture is a well-archived history, especially in the academic context of Deleuze studies. A claim for a reductionist subsuming of Deleuze's concepts in the encounter with digital architecture is a common narrative. See Hélène Frichot and Stephen Loo, eds., *Deleuze and Architecture*, (Edinburgh: Edinburgh University Press, 2013), a recent publication investigating these first encounters, containing feminist and post-structuralist critiques. See respectively Karen Burns, "Becomings: Architecture, Feminism, Deleuze – Before and after the Fold", and Marko Jobst, "*Why Deleuze? Why Architecture?*; see also Hélène Frichot, "The Forgetting of the Ethics of Immanence", *Architectural Theory Review Online* 17 no 1(2012): 27–39, accessed 25 October, 2016, http://www.tandfonline.com/toc/ratr20/17/1. For a similar critique directed at the production of the digital architecture of the 2000s. For a politically oriented critique of the reduction of Deleuze's concepts, see And Douglas Spencer, "Smooth Operators: Architectural Deleuzism in Societies of Control" (PhD Dissertation, Westminster University, 2012).

projective process defined as *variable* (Carpo 2011, x). Nevertheless, and in both cases, post-humanist practices remain on the methodological level, subjected to humanist and still modern ontology – that is to say, to an unchanged concept of the architect.

My cartography leads me in the direction of an alternative narrative: other digital precedents of the early 90s developing away from Deleuze's concept, which support a different narrative of novelty. I show how, across these examples (Eisenman 1992, 1993; Lynn 1992, 1993; Kipnis 1993; Frazer 1995; Spuybroek 1996; Weinstock 2004), there develops an underpinning of non-dualist, non-formal architectural methodologies that redefine the architectural process so that it is removed (at times only in principle) from what is perceived as human cognition, defined by vision and intellect, and is replaced by a non-dualist, materialist, emergent design process, alongside the humanist-formal. Framing digital novelty with post-humanist trajectory, which crosses geographical and temporal boundaries as well as methodological approaches is the first step in replacing the insistent humanist frameworks and establishing the non-human of such architecture. Therefore, this alternative reconceptualization of what novelty in the digital amounts to is the first step towards enabling a digital nomadic practice incorporating an ethical stance.

Chapter 2,

Cartography 2, Digital practices and methodologies

In this cartography I relate to two distinct digital practices, a topological-mathematical-based architecture and a biodigital architecture.

Part 1: Differentiating Points Of View – Situating Topological Digital Practice

In cartography 2, part 1, I show that mathematical differentiation is prevented in digital architecture practice because of axiomatic interpretation of methods that diverts it towards continuity. I retie the links, connecting current digital mathematical conventions (such as parametric architecture) with seventeenth-century developments in mathematics that have been incorporated into Deleuze's non-dualist concepts as the mechanism behind his alternative system

of relationality; I refer here to Leibniz's infinitesimal aspect of the differential calculus. Re-emphasizing this mathematical history also brings to the surface the mutation that the infinitesimal differential calculus has gone through: from a seventeenth-century esoteric mathematical concept to current mainstream mathematics, fuelling the computational turn, which is a mutation from a non-dialectic mechanism to a mechanism of control.

This shift cannot be conceptualized without addressing the philosophical component of Leibniz's mathematics. Leibniz's metaphysics introduce us to a world that is derived from non-dualist and relational processes. These processes define the point of view of an entity (organic, non-organic, human and non-human). In this cartography I show how, for Leibniz, processes of differentiating are differentiating *points of view* that define subjectivity. This return to Leibniz's *infinitesimal* brings to the fore a renewed understanding of the calculus as a process towards a determination of singularities.

However, a mutation of the calculus from its seventeenth-century origin and on to present-day topology has shifted the focus from the determination of singularities to the articulation of continuity – allowing for *folding* as well as underlining the mathematics beneath the popular digital modelling software Grasshopper (released in 2007), for example. The mathematical and the ontological converge briefly at the turn of the last century with developments in geometry made by Gauss and Riemann, developments that enabled the topological development made by Poincaré. These developments not only reintroduced the infinitesimal into the calculus, but also, introduced multiplicity to mathematics, which engender Deleuze's shift towards nomadism. At the end of *The Fold*: *Leibniz and the* Baroque, Deleuze dissolves the Baroque system that was maintained by the infinitesimal differential calculus and replaces it with a nomadic system. This shift holds significant implications for the infinitesimal. I show that the mechanism itself, the affective and relational differentiation mechanism, is still relevant, especially if, in line with the shift to nomadism, we can define its embodied aspect in nonunitary terms.

I suggest overcoming the introduction of axioms to the otherwise infinitesimal Leibnizian processes by reintroducing Leibniz's original theory of the calculus as the mechanism of derivation of point of view. In the last chapter of this thesis I seek to introduce the lost qualities of this mechanism – that of point of views, or singularities, in means other than mathematical, in relation to data as a first step in reintroducing embodied singularities into the digital architectural process, which I continue in the next cartography.

Cartography 2, Part 2 – Rethinking biodigital practices – From the genetic to the machinic

Cartography 2, part 2 is a cerography of novelty of biodigital architecture. This novelty narrative is defined by morphogenetic processes, which give rise to *emergence. Emergence* is defined as a post-formal methodology, by a new quality that arises from a self-governed 'material-led' process.[29] This digital architecture methodology is underpinned by biomimetic computational methodology, biomimicking the evolutionary process itself, as developed by John Holland (1960s–1970s), known as genetic algorithms. The first part of this cartography traces the mechanism and principles that underpin genetic algorithms, which I show to be operating a deterministic evolutionary interpretation because of their reliance on a genetic-oriented process differentiating through *fitness factors* as selection criteria. This deterministic methodology implies an active environment that transforms a passive organism, and further implies a disembodied conception of humans and others. The second part of this cartography turns to a recent occurrence in biodigital processes, a shift towards a direct engagement with the architectural matter through methodologies that seek to compute in architectural tectonics (Menges 2013). Here I show that these techniques revert to colonizing approaches to the natural matter, dislocating it from its environment.

I suggest overcoming these humanist ontologies (determinism and universalism) that direct post-humanist methodology (*emergence)* in digital architecture by

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[29] See Michael Hensel, Achim Menges and Michael Weinstock, "Introduction" in *Emergent Technologies and Design: Towards a biological paradigm for architecture* (Oxon, New York: Routledge, 2010), 12.

introducing alternative conceptions of evolution. The first is the concept of *umwelt* developed by the ethologist Jakob von Uexküll at the beginning of the twentieth century to suggest an active 'sensory soap-bubble' that warps every organism and determines their affective capacity. *Umwelt* is described by Elizabeth Grosz (2011) as suggesting an embodied and active revised understanding of *ecology* created by two organisms in harmony. In this cartography I show that Uexküll was influenced by Leibniz and that *umwelt* shares many similarities with the monad, and that Deleuze's scholarship is in turn influenced by Uexküll's ethology.[30] Since the monad has been proved obsolete by Deleuze, what is the meaning of this move to the concept of *umwelt*? *Umwelt* too, therefore, must undergo nomadization. Keith Ansell-Pearson describes a shift from emphasizing autopoiesis, as a process enclosed by an organism to a machinic conception of autopoiesis, a concept elaborated upon in *A Thousand Plateaus – the machinic phylum* (Deleuze and Guattari 2004 [1980], 448–52). What form can *umwelt* take in the machinic phylum? I elaborate on the potential of this undercurrent machinic flow to undo Menges's ordered phyla and to contribute to a broader, nuanced and differentiated notion of biodigital architecture. I frame the machinic in the context of digital architecture with data, which I further develop in the final chapter.

Chapter 3,

Transposing Digital Architecture – Towards a Nomadic Artisan

Throughout this thesis argue for the importance of an embodiment of the digital process as a means of inhabiting *points of view* and therefore as a means of differentiating qualitatively and ethically. In this chapter, I define this project as a political one, as a project that seeks to resist and reclaim nomadic embodied and relational practices from the grip of humanist ontologies as a means of establishing an ethical digital disourse. As I showed above, these are not mechanisms of forgetfulness that make the passage from state to nomadic

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[30] See Undine Selbach and Stephen Loo, "Insects and Other Minute Perceptions in the Baroque House," in *Deleuze and the Non/ Human,* eds. John Roffe et al. (Hampshire: Palgrave Macmillan, 2015), 109–10. See cartography 2, part 2 for the detailed discussion.

machines possible, but rather active yet silent processes of advanced capitalism. The way forward therefore is to establish a digital figuration, a mechanism for the articulation of the nonunitary subject in digital discourse.[31]

The cartographies of digital theory I undertake in the first and second chapters pave the way for the articulation of an apparatus that operates by means of differentiation (i.e. affirmatively). Such an apparatus responds to perceptions by means of having a body and by being receptive to affects from organic and non-organic sources equally. In short, we have the outline. In this closing chapter, I further develop the mechanism for its enactment in the digital realm, as part of a machinic flow of data. That requires first locating affcetual practice with an alternative socio-political practice that rearticulates the embodied as well as the non-dualist and nonunitary, as I draw on Braidotti (2011), and Massumi (2015). I deploy these conceptualizations of affect, therefore, as a means to navigate data flow. I develop this figuration on Deleuze and Guattari's *artisan* (*A Thousand Plateaus,* 2004 [1980], 451–8) as one who follows the machinic phylum. A digital artisan operates at the level of raw materiality and not in terms of end forms; it is the material that will find the forms according to data forged in accordance with one's *umwelt* (affectual capacities). A digital artisan diverts molecular methodologies already in place and active by advanced capitalism, but rather than following data in order to atomize and control, a digital artisan follows other types of data, covered, hidden, in the depth of the system as bodies and machines that empower the marginalized by enhancing their capacities as an ethical discourse.

Novelty as Difference

The departure point for this thesis is a reconceptualization of the very concept of novelty. Here I draw on Deleuze's *Difference and Repetition* (1968) for the articulation of a non-dualist system, defined by processes of differentiating as opposed to difference understood by dualist negation and which relies on static definition of essence. The main obstacle to the articulation of a non-dualist system is a representational relationality that thrives on a standard, and its derivatives. In the quotations below, Deleuze first lays out the mechanisms

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[31] See this Introduction below for a discussion of Rosi Braidotti's nonunitary subject.

behind a representational system, how they function in a way that produces sameness:

> We said above that representation was defined by certain elements: identity with regards to concepts, opposition with regards to determination of concepts, analogy with regards to judgment, resemblance with regards to objects. The identity of the unspecified concept constitutes the form of the Same with regard to recognition.
>
> [...] *difference becomes an object of representation always in relation to a conceived identity, a judged analogy, an imagined opposition or perceived similitude.* Under these four coincident figures, difference acquires a sufficient reason in the form of principium comparationis. For this reason, the world of representation is characterized by its inability to conceive of difference in itself, since the latter is grasped only by means of recognition (Deleuze 2004 [1968], 174, original emphasis).

Drawing on Foucault, Deleuze establishes four 'iron collars' of representation: identity in the concept, opposition in the predicate, analogy in judgement and resemblance in perception.[32] These are the pillars upon which classical, anthropocentric, humanist culture bases its practices of representation, as they coordinate and measure the extent of a discursive adherence to a standard. This system of symmetry and opposition, which is predicated upon a standard, is the key to understanding the mechanism of Western society with its reliance on the centrality of man. Deleuze traces it back to Descartes and Kant, to principles consolidated during the seventeenth and eighteenth centuries, which centres above all the rule of the human mind (the phallocentric mind) as the molar, the centre in all terms, but mainly, and crucially to this thesis, in political and social terms. Braidotti elaborates on the operation of 'doxa' that administers a respective anti-standard, which thereafter enables the dualist and negative appropriation of the *other,* and of taxonomies of difference ordered according to essentialist, fixed categories such as race, class and gender. Such a system is appropriated according to binary mechanisms such as the nature and culture

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[32] See Gilles Deleuze, *Difference and Repetition*, (London: Continuum, 2004 [1968]), 174.

divide and, moreover, the subordination of the natural to the cultural, the material to the conceptual.[33]

To overcome the centuries-old reliance on this system of representation in Western thought, Deleuze puts in place an alternative understanding of difference that cannot be defined by a reliance on essence but rather by a dynamic concept of becoming.

> Instead of the enormous opposition between the one and the many, there is only the variety of multiplicity – in other words, difference (Deleuze 2004 [1968], 230).

While undoing our Western heritage that chains thought to disembodied mind is a process that takes place in the philosophical, social and scientific realms, and in great effort with the work of continental post-structuralist philosophy, I would like to approach navigating these intellectual terrains while drawing on Rosi Braidotti's distinction between the semiotic and the materialist approaches of this ongoing project, for they entail a different approach to difference, which resonates in our current discursive milieu and therefore in the context of this thesis. However, and within the practices that we generally position as material, I differentiate further between two trains of thought: the nomadic feminist and the speculative realist. This distinction is not meant as performing another taxonomy but as a means of producing a practice that resists the mutations of new capitalism to encompass all differences. Such a distinction becomes apt when we move to discuss digital practice, when the currency of *immanence*, or immanent practice, escalates.[34] How can we identify difference that encapsulates matter as articulating a socio-political position without falling back either to fixed identities or to universal abstraction? It is this question in particular that fuels a feminist materialist discourse, which is absent on the whole from the articulation of *immanence* in digital architecture practice. Therefore, while a new materialist approach is thriving in digital practice, it is more often than not

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[33] See Braidotti, *Nomadic Theory*, 6–7, 34.
[34] For example, in the work of DeLanda. I refer to his works in cartography 2, part1.

masquerading a universalism and disembodiment, with an appeal to novelty framed by lingering humanist, dualist principles.[35]

The emphasis on difference is a common thread in feminist scholarship, but it is important to locate this thesis as promoting difference understood as a non-dualistic practice; as such, it seeks notions of differing, the 'variation of the multiple' rather than the fixed notions of difference, as well as an embodied aspect.[36] It is this insistence on specific bodies that I find missing from other branches of new materialist thinking. I locate such importance on these practices of situating, albeit one that overcomes a return to fixed identity, as the key to unfolding digital practices of difference; such a practice is suggested by Braidotti's reconceptualization of subjectivity as nonunitary, which she entitles *nomadic subjectivity.*

The main question this thesis discusses is what figurations of difference framed by such non-dualist, affirmative, embodied and nonunitary discourse can we imagine in digital architecture? This question brings me to the next topic, that of subjectivity.

Nomadic Nonunitary Subjectivity

As we just saw, nomadic theory stresses that the material is never separated from questions of location. It is this coupling that sets nomadic theory apart from other new materialist strands. How can the subject adhere to the laws of materiality, decentred from its human faculties, undone from essence and identity and at the same time be located? Located in what? And how?

Drawing on Deleuze, who began redefining nomadic subjectivity in terms of the change it requires in our preconception, understood as a departure from the thinking subject, as Braidotti explains:

> The thinking subject must be dissolved into the elements which compose him/her; these elements are affective, not rational, *pathos,* not *logos,*

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[35] This is evident in the work of Lars Spuybroek as well as in biodigital architecture, in the work of John Frazer, Michael Weinstock and Achim Menges, all adhering to a material, form-finding practice in architecture. See Cartography 2, part 2.

[36] For a discussion on the various feminist approaches to matter see Iris van der Tuin, "'Jumping generations': On second and third wave feminist epistemology", *Australian Feminist Studies* 24 (2009), 17–31, DOI: 10.1080/08164640802645166.

reason itself being only one possible way of affecting the body. In adopting this stance Deleuze emphasizes the notion of 'intensity', by setting it in opposition to representation, because it expresses the degree of affirmative power of a body, and is therefore capable of demonstrating difference (Braidotti 1991, 114).

Braidotti too refers to *Difference and Repetition* for further qualification from Deleuze, as she quotes: "'The individual in intensity recovers it in the cracked I and the dissolved Ego, and in the correlation between them.'" 'Deleuze,' Braidotti goes on to explain,

> suggests moving beyond the dialectical philosophical scheme which makes the Ego the object of the subject I, to envisage affective or energetic relations as the basis for the production of meaning. He introduces his impersonal view of subjectivity, elaborating it in the course of his critique of psychoanalysis. The latter is, for Deleuze, yet another variation of method of application of the classical principle of representation (ibid.).

That is to say that the definition of subjectivity as engendered from a definition of identity is dissolved, rather; '[T]he subject is for him [Deleuze] a molecular model, an infinity of particles, attributes and modes of being. It is opposed to the molar substance composed of essential attributes as grasped by the Cartesian cogito' (ibid., 115).[37]

Positioning the subject with non-dualist intensities is not without its challenges. For example, Braidotti points to a common feminist critique of Deleuze's radical immanence on the grounds that dissolving the concept of the *other* also dissolves empirical bodies and struggles and annuls gender and sexual differentiation altogether and thereby mutes women's voices and struggles and particularly their rights over their bodies, without their gaining them first as part of full emancipation. This in turn, Braidotti stresses, may lead to 'women's disappearance from the scene of history, their fading-out as agents of history' (ibid., 119) as part of this radical anti-humanist shift.

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[37] As such, Deleuze's subject is placed in the domain of political philosophy, critiquing both totalitarianism as well as liberal theories of the social contract. See Braidotti, *Patterns of Dissonance, A Study of women in contemporary philosophy* (New York: Routledge, 1991), 115, for the detailed discussion.

In later writing, Braidotti reassesses her early critical stand, reframing her position in enabling terms: 'In the longer run, however, the radically projective concept of intensive Deleuzean subject opens the door to possible configurations of variety of subject positions that are post-metaphysics' (Braidotti 2000, 162).[38] Such is her own re-articulation of nomadic and nonunitary subjectivity. Braidotti compensates for the seemingly abstract, or absent, aspect of the human, by rendering simultaneously its embodiment and embedment as well as its nonunitary or machinic aspects in her construction of the post-human. I place nonunitary subjectivity here as complementing Deleuze's 'grounding' element in the germinal, or the molecular.

Nomadic thought is an expression of a nonunitary vision of the subject, 'defined by motion in a complex manner that is densely material. It invites us to rethink the structures and boundaries of the self by tackling the deeper conceptual roots of the issues of identity' (Braidotti 2011, 3). Braidotti's nomadic subjectivity should be understood in detachment from notions of individualism, or any ego-indexed or fixed understanding of selfhood.[39]

Braidotti frames the post-human in terms of *nomadic subjectivity* that operates by a careful and methodical removing of essentialism from a definition of the human subject; replacing static definitions of identity and the hermetic grip of the presumptuously all-knowing role that consciousness plays in Western narratives with an altered mediation with the world, equipped with alternative concepts that better react to a spatiotemporal discontinuity and multiplicity. That is to say, the main humanist tool of being in the world – cognition – is thereby replaced with *affect* and *desire*, static belongings are replaced with a molecular distributions of multiple communities, not bound by the boundaries of a body, because, these boundaries are proven already to be violated, either by information technology or by biotechnology. Such alternative bonding defies

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[38] This is part of a discussion addressing specifically correspondence between Deleuze and feminist theory, complied by Ian Buchanan and Claire Colebrook. See *Deleuze and Feminist Theory,* eds. Ian Buchanan and Claire Colebrook (Edinburgh: Edinburgh University Press, 2000.

[39] Post-structuralist philosophy has produced other concepts and practices of nonunitary political subjectivity: the 'split subject' of psychoanalysis, Foucault's subject in process, the 'sexed subject which is not one' of Irigaray, and Deleuze and Guattari's rhizomatic complex. See Braidotti, *Nomadic Theory,* 4–5.

traditional definitions of identity along blood/ class or to earth relations. Subjectivity on the one hand is contained within a specific body yet at the same time it is redefined by collective flows of memories, genetic flows and continuous bodily interactions in a process of becoming that is infinitesimal in its potentiality but limited by the specific bodily differentiations and perceptual capacities. Such a porous understanding of the body is posited as an alternative to the modern perception of subjectivity centred on a self, on a constant notion of identity in a predetermined body.[40] Braidotti suggests '[r]ethink[ing] the embodied structure of human subjectivity after Foucault' (Braidotti 2000, 158), through a reworking of Deleuze's enfleshed subject as an 'in between': 'it is the folding in of external influences and a simultaneous unfolding outwards of affect'. Braidotti sums up this reconceptualization of the subject as 'embodied memory' (ibid., 159).

Braidotti is interested in the areas of discussion where the perception of the subject has been altered by biotechnology and information technology. This entails an ontological shift, as it moves the discussion of the human body, or 'Life', from the realm of object of analysis to realm of the subject. It is this role-play reversal that I am most interested in accounting for, as it entails a shift towards immanent understanding of life (or, in Braidotti's terms; 'life as *Zoë'*). Uncovering processes of becoming, Braidotti further explains that the point of nomadic subjectivity is to identify a line of flight – that is to say, a creative alternative space of becoming that would fall not between the mobile/ immobile, the resident/ the foreigner, but within these categories.

I would like to stress the importance for nonunitary subjectivity of engaging with questions of diversity and singularity of this architectural world that is still immersed in centuries-old traditions of modernity. In digital architectural terms, such an immersion in modernity translates to the schism between universal ideals and individual solutions, both having proved insufficient to address our

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[40] Such a repositioning of the forces that define subjectivity are seen as an alternative to the Descartean and neo-Kantian tradition that centres cognition, nor is it a purely social entity, and as such positioned as an alternative to Marxism, as well as in dispute with Freud and Lacan's emphasis on desire as lack and on the Hegelian-based current psychoanalytic obsession with identity formation. See Rosi Braidotti, "Taratologies", in *Deleuze and Feminist* Theory, Eds. Ian Buchanan and Clair Colebrook (Edinburgh: Edinburgh University Press, 2000), 159–60.

current multiple position. How do we articulate *difference*? How do we articulate the singularities making up our societies without atomizing them? – which, while facing the globalized environmental and economic challenges, proves impossible, where universalized, central solutions do not allow for the flexibility required to deal with these challenges. Digital architecture heads in the direction universalized solutions masked in tapes of continuity. The aim of this thesis, therefore, is to undo the relationality that allows for these practices of masking and false connecting, while at the same time introducing alternatives for the reincorporation of singularity, of difference that does not rely on atomized notions of fixed identity. Such thinking of subjectivity along collective lines carries a political significance.

Braidotti identified the need to investigate a new individuation of the nonunitary, especially amid external machinic mutations, as a means to gain an upper hand with advanced capitalism's move to erase differences:

> I have argued for the need to rethink the embodied structure of contemporary subjectivity in terms of the convergence of biotechnologies and information technologies and the proliferation of commodified differences which they engender. The biological and the informational bodies converge into a new subject compound, which is nomadic and hence not unitary, hybrid and hence impure, and denaturalized through technological mediation and hence post-humanist (Braidotti 2006, 96).

This is our current location. Throughout the course of this thesis I go back to this meeting point between Deleuze's concept of nomadism and Braidotti's re-articulation of her own nomadism, rendering possible convergence and mutations that inform the development of a digital nomadic subjectivity, differentiating amidst digital data flow.

CHAPTER 1 –

CARTOGRAPHY (1) – DIGITAL NOVELTY NARRATIVES

Introduction – From Folding to Scripting: Towards Nomadic Algorithmic Thinking

This cartography has a twofold aim. First, it sets out to cartograph digital architecture's narratives of novelty as they have developed since 1993 in histories and theories of architecture literature. Secondly, it aims to propose an alternative to these main concepts of novelty. As such, it unfolds a process of convergence occurring in architectural thought; that is, the shift from humanist to post-humanist approaches in the development of what we now refer to generally as digital architecture. It addresses the problematic understanding of concepts of novelty in digital architecture discourse, concepts that are aligned predominantly with the formal and instrumental understanding of novelty, despite the new ontologies opening up to architecture as a practice with the introduction of digital and, by definition, post-representational methods to the production of architecture. That is to say that the shift to digital and post-humanist epistemologies in digital architecture operates in an absence of a discussion of this shift in ontological terms – that is, in terms of its impact on subjectivity position.

This condition is broadly acknowledged by Rosi Braidotti as that which hinders *real difference* and which is further conceptualized as a structural problem in need of being addressed. These structural conditions, claims Braidotti, can be overcome only if alternative concepts of novelty emerge; such concepts call for articulating one's *location.* Location calls forth epistemologies that register embodiment and embedment. It is important to note that both these concepts,

embedding and embodying, are understood by Braidotti away from their humanist-centred definition altogether, as she emphasizes a nonunitary and non-fixed definition of location. Braidotti privileges materialist and affectual qualities of perception that replace humanist reliance on centrality and unity in the construction of the subject that translates to cognition-vision-centred methodologies. *Cartography* is a methodology proposed by Braidotti to specifically uncover the inherent and persistent traditional, humanist patterns of thought which, although they embrace post-formal, materialist epistemologies, nevertheless disregard the need to reconceptualize subjectivity accordingly, along similar materialist and post-human lines. Such neglect, postulated Braidotti after Deleuze, forever introduces sameness rather than novelty/ difference.

This chapter draws on Braidotti's critique as well as on her methodology. Cartography here is seen as a means to locate the discourse, to embed it in its various genealogies by questioning the narratives of novelty in digital architecture and to undo their adherences to post-formal novelty narratives while keeping to a humanist conception of its articulation – a stance, I argue, that results in non-critical discourse. This cartography therefore is aimed at unveiling these deep structures of humanist thought, and exposing the modernist chains burdening architectural history as a first step towards bypassing them by accounting for alternative genealogies. This is to say that locating the discourse allows for a simultaneous new understanding of the potential for novelty in digital architecture to unfold. This dual aspect highlights the creative and affirmative agenda of nomadic theory in producing new concepts while undoing old links as the first step in a process of rethinking the digital subject.

This cartography address three novelty narratives of digital architecture – *folding, non-standard* and the *algorithm* – and explores the premise of their articulation and the criteria they apply to claims for the production of a new paradigm of architecture. These attempts to theorize the new digital paradigm in architecture were consolidated as part of publications, exhibitions and scholarly texts published over a period of two decades (1993–2013), all of which share the claim for a new paradigm in architecture, inadvertently though – on the premise

of a shift towards post-formal methodologies, however differing in their genealogies, references and chronologies. This cartography exposes the discrepancies and gaps in the arguments these narratives formulate in relation to the production of novelty, which stem, I show, from their ontological reliance on humanist models of thought. Further, this cartography shows that *folding* as well as *non-standard* and the *algorithm* are methodological derivatives of a broader ontological shift. That is to say that these digital narratives overlook the turn to post-formal digital techniques in architecture as part of a larger turn to what can be defined as a post-humanist turn, brewing since the 1990s, and in consequence overlook the ontological implication of such a shift. This cartography shows that this turn to digital as a post-humanist quest spans wide geographies and methodologies, out of which *folding, non-standard* and the *algorithm* are its operational outcome, amongst others that are omitted from the main historiography, other hubs of early digital production supporting emergent biodigital methodologies, inspired by a turn to complexity theories in biology and other sciences. These early digital production examples mark a similar post-humanistic trajectory in the early exploration of digital architecture. This position, however, is not accounted for in digital literature.

My emphasis on digital architecture as emerging in response to general interest in post-humanist methodologies is at the same time a cartography of the absent concerns to the post-human as an ontological condition that needs addressing in the architectural context if we are to claim real difference/ novelty in the production of digital architecture. This cartography therefore grounds and embeds by a process of unfolding humanist models of thought as a first step towards unfolding discrepancies and sidestepping an insistence on the binaries of internalized architectural discourse. It stresses digital architecture as a discourse thriving on interdisciplinary entanglement, and acknowledges the potentiality in these non-deterministic, non-dualist, non-representational methodologies to enable materialistic, dynamic and unfolding relationality in architecture that is at the same time positioned, embedded and embodied, while still being nonunitary.

Folding (1993, 2004)*,* the first narrative I address, draws on Deleuze's *The Fold.* The influence of *The Fold* was originally positioned as operating to displace human vision and replacing it with calculus-based *continuity*. At the same time it is positioned as a new architectural 'style'. This narrative positions novelty with a formal solution as well as a new relational process, stemming loosely from mathematics (Lynn 2004b, 10; Carpo 2004, 2013; Picon 2010, 63–5). The second narrative – The *Non-standard* (2004) – addresses the new architecture as replacing concepts of formal production with non-standard analysis in mathematics, or in general with mathematical calculation. This narrative bridges digital with post-formal, calculated architecture produced in the twentieth century. It replaces one humanist narrative (form) with another – namely with rationality (Migayrou 2009). Narrative 3 – The *Algorithm* (2006, 2011) – is identified with the proliferation of digital tools as well as digital theory and thought, and places the cause for novelty in the computational realm, with the algorithm (Terzidis 2006; Carpo 2011; Burry 2011; Picon 2010).

When addressing folding as a narrative, I distinguish between two layers of discursive formation; the first is the original 1993 *Folding in Architecture* publication, which was the first to frame the new architecture with this term. This publication is the official meeting point between *The Fold* and architecture and where *The Fold*'s chapter 1 was first published as part of an architectural discussion on new concepts of architecture. The main questions that lead this discussion is the correspondence between the themes and projects outlined in *Folding in Architecture* and Deleuze's *The Fold*. The second discursive layer is the 2004 reprint of *Folding in Architecture*, where the magazine's main themes are reframed by Mario Carpo and Greg Lynn retrospectively, and a narrative of folding as a new architectural and digital style emerges. The first discursive layer exposes an approach, which can be summed as a sympathetic, if limited-in-scope-approach to Deleuze's post-human ontology. This approach, termed as *folding*, is practised by Lynn, Eisenmann and Kipnis who took part in the first 1993 edition. In the second discursive layer, the 2004 reprint, *folding,* rather than being acknowledged as a new ordering system, is discussed in terms of a new style, stressing its continuous formal qualities, therefore still in the realm of

formal representation and within humanist reach (for example, in Lynn 2004b, 10; Carpo 2004, 2011, 2013). This account is therefore an account of reduction; a reduction of folding ontology in favour of a new architectural epistemology emphasizing formal qualities rather than a new process, or rather, a reduction emphasizing humanist ontologies.

The second narrative of novelty is a mathematical one framed by the first major exhibition dedicated to digital architecture that took place at the George Pompidou Centre, Paris (2003–4) entitled *Non-Standard Architecture.* The exhibition was co-curated by Frédéric Migayrou with Zeynep Mennan, who articulated the new architecture as stemming from mathematical process known as *non-standard* analysis, which emphasized the role of calculating as replacing representational and formal architectural methodologies. At the same time, this narrative replaces representational-formal-human processes of 'old' architecture with a narrative of novelty as pure rationality, still embedded in humanist ontologies as well as struggling to locate the digital aspect of the new architecture, because it explains the new architecture by the mathematical concepts underlying its computational processes, broadly linked to non-standard analysis (discovered by the mathematician Abraham Robinson in the 60s).

The third site of my cartography addresses the reduction of post-humanist ontologies into post-humanist epistemologies in theories that define digital novelty with the *algorithm*. I refer to two different prisms of algorithmic architecture production accounts; architectural-technical account of Kostas Terzidis (2006) and historical-theoretical narrative of the algorithm developed by Mario Carp (2011). In this section I show that, despite the shift to account for novelty in digital architecture in post-humanistic terms, these still frames an epistemological account, while the overwhelming ontological framework of the histories I discuss operates on modern and humanist grounds. Both Terzidis and Carpo explain the rise of the algorithm as the focal point of novelty in the digital, explained by a shift from the formal to the generative, digital-infused methods of the new millennium, describing the algorithm's capacity to overturn modern and humanistic methodologies in architectural design. For example, Terzidis aligns

the future of computation with *algorithmic architecture* and renders the scope of the algorithm to shift digital architecture from a determined, architect-led process to an open-ended, emerging design process. Carpo reflects on the algorithm's capacity to overturn 500 years of the *identical* paradigm, defined by its projectional methodology that centres vision, with a paradigm of *variability,* supported by non-projective methodologies. Both historians acknowledge a departure from modern, humanistic architectural history; however, I show that this departure is epistemic in approach and does not overturn modern, humanistic ontology. These narratives do not take account of their hybrid stand, which hinders a grounded debate on the production of qualitative difference. I emphasize this point of tension because I would like to argue that this lack of distinction is one of the causes for the ease with which digital architecture is equated with formal exuberance, a critique that has been voiced by many.[41]

This leads me to my second argument. Replacing post-humanist concepts with reductive formal/ rational/ human perceptions is part of a wider theoretical oversight, which misplaces, or rather omits, an entire materialist genealogy from the historiography of digital architecture's formative years. I show that the scope of digital architecture is wider, geographically and methodologically, than was encapsulated in these three narratives. Other architectural hubs developed an interest in post-formal methodologies to architectural design, which cannot be limited to the above narratives. I refer here to architectural materialist experiments at the *Architectural Association School of Architecture* (London) of the late 80s and early 90s. These explorations were channelled via biomimetic methodologies, such as genetic algorithms (John Frazer 1995) and morphogenetic techniques (Michael Weinstock and Michael Hensel 2010), both of which are post-formal. Their work supports my alternative narrative, according to which the novelty of the digital turn to architecture should be understood as stemming from a post-formal quest in architecture. This post-formal quest is by nature of its methodologies also post-humanistic, remaining,

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[41] For a sober retrospective look at his role in eliciting such a perspective Bernard Cache, "Projectiles", in *Projectiles*, ed. Bernard Cache (London: AA Publication, Architecture Words 6, 2011), 16.

however, entangled in formal/ rational/ positivist or, in other words, humanist-modern ontologies and therefore unable to produce real difference.

I would like to pause and reflect briefly on the shift to modernity, and particularly on two distinct histories that emerge in the 1930s and 40s. I am looking back to this historical example because I am reminded by it of an alternative account of historical processes in architecture that defies the instrumental one – against the backdrop of either the instrumental narratives that highlighted functional aspects of modernism (thriving in American academia under the auspices of Mumford and Fuller) or the popularization and commodification processes of the modernist avant-garde and its repositioning as a style, that came to prominence with the MoMA 1932 exhibition entitled *The International Style*, curated by Henry-Russell Hitchcock and Philip Johnson.[42] I would like to recognize the role of the architectural historian Sigfried Giedion in what I can refer to as cartography of modernism, for his cross-disciplinary, situated research, which cuts across continents, times and disciplines. His historiography identified a new ontology in the texts and projects of the first generation of the European avant-garde (1920s and 30s). Giedion argued for a new *space conception* known as *space-time,* which defines the modern era, just as perspective defined the Renaissance. Giedion claimed that the new movement should be recognized by dynamism and indeterminacy, which he attributed to the art and science of his time. His texts were deeply rooted in neo-Kantian philosophy. These alternative concepts were developed in his *Space, Time and Architecture: The Growth of a New Tradition* (1941) and in the earlier *Building in France. Building in Iron. Building in Ferro-Concrete* (1928) and were later communicated to his students at Harvard.[43]

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[42] In an unpublished paper submitted as part of my Histories and Theories MA at the *Architectural Association* (2006), "Processes Leading to the Commodification of architectural European Avant garde in post WWII America: The pivotal role played by Mies", I argued that *The international style* contributed to the commodification of the complexity of the modernist European avant-garde.

[43] See Detlef Mertins, "System and Freedom: Sigfried Giedion, Emil Kaufmann, and the Constitution of Architectural Modernity", in *Autonomy and Ideology: Positioning an Avant-Garde in America,* ed. Robert Somol (New York: The Monacelli Press, 1997), 212–31 for a detailed account of Giedion's theories and their reception in the American academic landscape during and after the WWII. This book resulted from a conference held at Columbia University in 1966, hosted by the Canadian Centre for Architecture, reflecting on the development of the

I am reminded of Giedion's grounded position in relation to *Folding in Architecture* as the publication that is most identified with establishing the first narratives of novelty for a generation of digital architecture, especially from the standpoint, voiced several times in the 2004 republication, that the digital era was narrated at a period when technology was lagging behind the development of post-formal quests. So were the biodigital experiments. Therefore, instrumental narratives that emphasize continuity in terms of technological evolution, especially in computer science, as a means of explaining the digital age in architecture are insufficient.

The following investigation takes a certain rhythm: first, I outline the existing narratives; secondly, I discuss the voids in the narrative; and, thirdly, I discuss the shortcomings of the hybrid and unaccounted for positioned presented to produce a theory of novelty in digital architecture. Finally, I show how reconceptualizing novelty with nomadic theory opens ethical paths to digital architecture. My cartography exposes this narrative linearity as a false one, while uncovering vertical undercurrents in operation under the main narrative radar, and as part of a transpositional flow of materiality. Traversing this discursive immersion in humanist ontologies and their potential transposition into post-humanistic and finally to nomadic sites in a later stage. These sites are developed in relation to nomadic and feminist theory (Deleuze 2004 [1968]; Deleuze and Guattari 2004 [1980]; Braidotti 2006, 2011) with an emphasis on non-dialectic, material and situated practice.[44]

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architectural discourse in America 1923–1949. It is interesting to note that Philip Johnson, who was interviewed by Jeffrey Kipnis at that conference, acknowledged the role he played in developing the reductive approach American academia has taken toward modernism, reflected that in retrospect, the intellectual and artistic agenda of the European movement was ignored, the movement's only revolutionary dimension adopted with the 'immigration' to the USA being aesthetic, declaring: 'we killed the avant-garde by making it a garde'. See Philip Johnson and Jeffery Kipnis, "A conversation Around the Avant Grade", in *Autonomy and Ideology: Positioning an Avant-Garde in America,* ed. Robert Somol (New York: The Monacelli Press, 1997), 43.

[44] See the introduction for a lengthy discussion on transpositioning as one of my main methodological concepts.

Narrative 1: Folding

Figure 1: Folding in Architecture, Deleuze's *The Fold*, chapter 1 (right) with Eisenman's Rebstock Park project (left)

No other publication epitomizes the initial aspiration to imagine a post-representational architecture better than *Folding in* Architecture, and not only because its guest editor, Greg Lynn, had juxtaposed chapter 1 of Deleuze's freshly English-translated *The Fold* alongside the texts and projects compiled in this edition. The potential that Lynn, Eisenman and Kipnis saw in calculus-based architecture and in René Thom's topological catastrophe diagram to put forward an architecture that can be undone from centuries-old human-centric concepts and methodologies is self-evident in the texts and projects they contributed to the magazine. [45] These post-formal experiments are nevertheless repositioned

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[45] The mathematician René Thom (1923–2002) is mentioned by Deleuze in *The Fold* as part of a discussion of transformation along a curve, or 'inflection'. Deleuze defines Thom's transformation as *projective* as he writes: 'René Thom's transformations refer in this sense to a morphology of living matter, providing seven elementary events: the *fold*, the crease, the dovetail, the butterfly, the hyperbolic, elliptical, and parabolic' Deleuze, 2006 [1988], 16. Simon Duffy refers Thom's *catastrophe theory* to a branch of geometry that 'attempts to model the effect of continuous variation of one or more variables of a system the produce abrupt and discontinuous transformations in the system' Duffy 2013, 19. The seven event described above

time and again as part of a humanist-formal ontology. In *Ten years of folding*, the historical review Mario Carpo contributed to the 2004 reprint, the emphasis is no longer on the fold as an alternative system to the dialectics of architectural production, but rather, Carpo suggests the fold as a stylistic and formal expression of architectural fatigue with the angularity of deconstructivism, highlighting *continuity* as Deleuze's main conceptual contribution to this generation of architects and beyond.

What is the correspondence between *The Fold*, a post-humanist, non-dialectic account of relationality, which places affectual, ethological sensibilities as a key mechanism to replace human perception of knowledge, and which leads to a calculus-based emergence and between the projects appearing side by side to its chapter 1 on the pages of *Folding in Architecture*? Questioning this encounter is made especially relevant on the backdrop of critical theory view of this encounter as a missed opportunity, and by and large, as reduction of Deleuze's complexity into a formal ideal.[46] In the discussion that follows, I return to the original texts with the aim of peeling away the narrative that was later put together by Mario Carpo.[47] I therefore return to the raw materials of the original publication, closely rereading the texts and projects. I begin with accounting for the way Greg Lynn, Peter Eisenman and Jeffery Kipnis frame the shift to the new architecture.[48] A few aspects are shared by all three architects/ writers, the first of these is that the new architecture of the 90s was developed away from digital computational platforms, which is a comment that could be made only in hindsight. In the reprint, Lynn reflects:

> It is significant that the architects included in this publication, have all formed their ambition for a new model of formal and spatial complexity

by Deleuze refer to the curves or functions of Thom's. See Cartography 2, part 1, for a contextualized mathematical discussion of René Thom's contribution.

[46] See in the introduction to Frichot and Loo, *Deleuze and* Architecture, 2012. In the same piblicaton, see Karen Burns, "Becomings: Architecture, Feminism, Deleuze – Before and After the Fold", 16 and Marko Jobst, "Why Deleuze, Why Architecture?", 67.

[47] Carpo reiterated this narrative in 2013 (*Twenty Years of Digital Design*), both these publications are *Architectural Design* special additions, celebrating respectively the 10th and 20th anniversaries of the 1993 *Folding in Architecture* issue (published by Wiley-Academy).

[48] It is important to note that, in the context of Eisenman's three projects that feature in this publication guest-edited by Lynn, that Lynn was Eisenman's student and worked as an assistant on Eisenman's Rebstock project.

before the advent of inexpensive, ubiquitous spline modelling software (Lynn 2004b, 10).

A second aspect shared by all the contributors is positing their own architecture simultaneously as a reaction against the 1990s' latest mutation of postmodernism – deconstructivism, and as such supporting a new style, but at the same time as a new ordering principle.

In each of these writings and to varying degrees, Lynn, Eisenman and Kipnis manifest conflicted relationality to Gilles Deleuze's *The Fold*. For *folding* as a new ordering system defies representational approaches to architecture that support a linear and fixed relationality directing the architectural process according to Euclidean geometry (such as plans and elevations), controlled by an architect as the subject of the architectural process, and the temporal and intellectual separation of the design process from the construction process, and moreover the subjection of the latter to the former. At the same time, all three appreciate folding as a spatial solution and describe it in aesthetic terms. This dual stand exhibits a tension, an unaccounted-for tension, simultaneously arguing for a new ontology as well as for a new style. Why these two cannot coexist? A new style inevitably posits itself in a dualistic relationality against an existing style (folding is suggested as a reaction to the fragments of deconstructivism), and by assuming such a position, folding operates within formal regimes of representation. A new ordering system, after Deleuze's topological, differentiated relationality, stands for a different ontology altogether, an ontology that posits itself as an alternative to representational, dualistic thinking.[49] How can the two, representational and differential ontologies coexist? I linger on this entanglement, for I argue that this muddled stage of discourse still haunts our current digital age.

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[49] See introduction for a discussion of the importance of concepts of representation to the operation of a humanistic, anthropocentric world as one of the main concepts of Deleuze's early work *Difference and Repetition* (1968).

Folding in Architecture; Between a New Style and a New Ontology
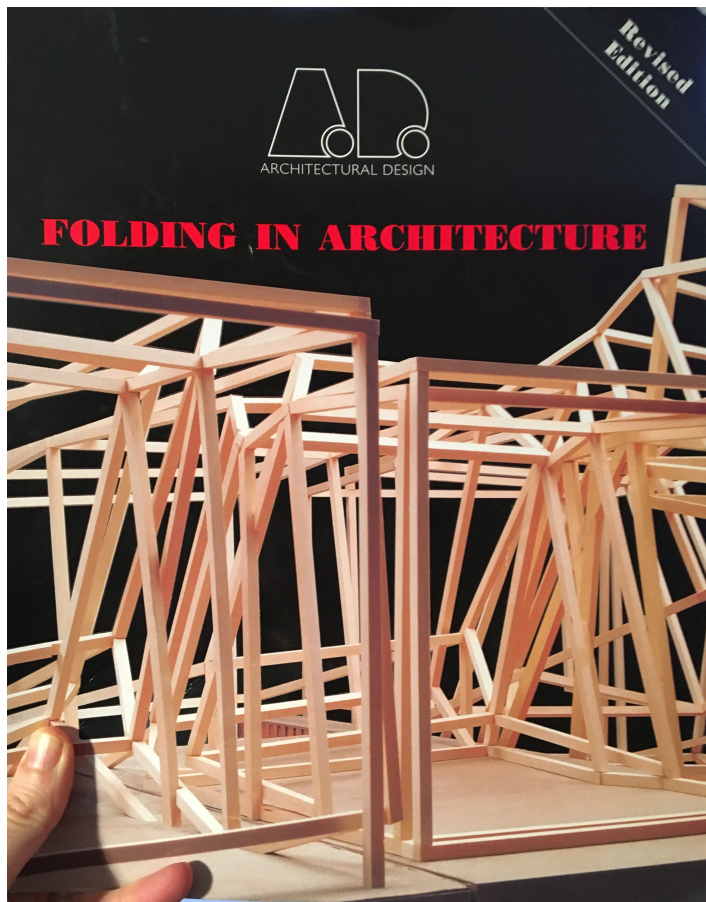
Figure 2: Architectural Design: Folding in Architecture, 2004, Cover image

My rereading of Lynn, Eisenman and Kipnis emphasizes the dual existence of these two distinct systems: the stylistic, which implies a reliance on representational ontology and therefore on a modern, humanistic, realm, and at the same time their adherence to a new ordering system based on a seventeenth-century mathematical model that allows it to operate without a model, without a standard, without typology. This is the topological model based on the differential calculus.[50]

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[50] I unfold in depth the mathematical and philosophical principles behind monadology in the coming chapter.

Lynn conflating between stylistic and ontological analysis

Figure 3: Greg Lynn, reconfiguring the Sears Tower, model, Chicago, 1992

In his 1993 contribution entitled *Architectural Curvilinearity, The Folded, the Pliant and the Supple,* Greg Lynn's departure point is a rejection of postmodernism's perception of architectural complexity as the first explanation to new concepts in architecture:

> A diagonal dialogue between a building and its context has become an emblem for the contradictions within contemporary culture. From the scale of an urban plan to a building detail, contexts have been mined for conflicting geometries, materials, styles, histories and programmes, which are then represented in architecture as internal contradiction [...] Through contradiction, architecture represents difference in violent formal conflicts (Lynn [1993] 2004a, 24).

Lynn's counter proposition is not a return to a *human* modern approach,[51] Lynn's proposal bypasses the dualism inherent in modernism and

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[51] Such as that advocated by Kenneth Powell's paper in the same publication, "Unfolding Folding", *Folding in Architecture*, 23. Powell sees the new architecture in continuity with the individualist approach in modernism that he attributes to Alvar Aalto, Wright and others. It is the 'humane' as a category that drives Powell's text, as the quality of architecture that characterizes the above architects, as well as constructivism. Constructivism is depicted as a subversive movement, a revolutionary one that could not be sustained, hence the new generation of architects (who, nevertheless, were part of deconstructivism), 'who seek to address issues (especially those related to the life of the city) in which confrontation cannot be all' (23). Against the backdrop of Alto and Wright, it is the organic, soft form that Powell identifies with the new

postmodernism alike: 'Presently, an alternative smoothness is being formulated that may escape these dialectically opposed strategies'. This approach is entitled 'post-contradictory' and it emerges in reference to the following fields: 'topological geometry, morphology, morphogenesis, Catastrophe theory or the computer technology of both the defence and Hollywood film industry' (ibid., 24). Such a smooth system is identified as that which is made up of distinct elements, which 'maintain their integrity while being blended within a continuous field of other free elements' (ibid.). It is here that Lynn brings up Deleuze, in the context of his definition of smoothness as 'the continuous variation' (ibid.). The ontological significance of such a system is not avoided by Lynn, who declares: 'For the first time perhaps complexity might be aligned with neither unity nor contradiction but with smooth, pliant mixture.' Such architecture, concludes Lynn, leans towards 'alliances, rather than conflict between elements' (ibid.). Lynn further claims an external force that 'intricates these elements with one another' which is 'outside of the individual elements' control or prediction'. Simultaneously, and at the same time, Lynn addresses the new architecture in formal attributes, as 'expressive', 'neo-Baroque' and 'curvilinear' (ibid., 25). This tension between these two interpretations of *The Fold* persists throughout the text, acknowledging the complexity entailed by Deleuze, as he emphasizes that the new techniques do not seek to represent collisions formally, but rather to accommodate complexity through continuous flexible systems.[52] Despite this manifested sensibility to elaborate the underpinning conditions, it is nonetheless the curvilinearity that has gained centre stage.

Lynn's methodology at this stage includes René Thom's catastrophe diagram,[53] stating that 'Topological geometry in general, and the catastrophe diagrams in particular, deploy disparate forces on a continuous surface within which more or less open systems of connection are possible' (ibid., 29). Lynn's own 1992

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architecture approach. *Humane* therefore refers to the order of expression, a formal expression that Powell also finds in Eisenman's work. In other words, it is the final architectural form that is Powell's criterion – the 'flexible and flowing, soft edged approach to architectural design' (ibid.). Powell addresses these forms as decorative, sculptural forms, qualities that he attributes to Baroque architecture.

[52] See Lynn, 2004a, 25–6.

[53] See above.

project presented in the magazine, *Chicago's Sears building* methodology is described as employing fluid dynamics 'which cannot reduce matter to purely geometric or ideal quantities' (Lynn 2004c [1993], 99). Lynn further emphasizes two additional characteristics: 'The stranded Sears tower […] defers any single organizational idea for a system of local affiliations outside itself.' And the second is that the connective paths between the building and the site are not predetermined, but rather are 'unpredicted', 'supple and flexible internal order of the "bundled tube" that is differentiated by the external forces of the river edges, the Chicago grid and the vectors of pedestrian and transportation movement' (ibid.). There is no reference to a specific methodology or detailed techniques; however, the *ontology* is in place, one that can only be described as post-formal, materialist and immanent. The Sears project is dated to 1992, while Deleuze's *Le Pli* was published in English only in 1993. It is more likely that Lynn is referring here to *A Thousand Plateaus* (published in English in 1988), where the general distinction between the hylomorphic and nomadic architecture is already in place.[54]

Peter Eisenman

In a 1992 essay published in *Architectural Design*, Eisenman makes an open plea for problematizing the human-centric relations between the centrality of vision and architecture, guiding architectural production since the sixteenth century because 'as long as architecture refuses to take up the problem of vision, it will remain within Renaissance or Classical view of its discourse' (Eisenman 2013 [1992], 18).

> It was thus not without cause that Brunelleschi's invention of one-point perspective should correspond to a time when there was a paradigm shift from the theological and theocentric to the anthropomorphic and anthropocentric views of the world. Perspective became the vehicle by which anthropocentric vision crystallised itself in the architecture that followed that shift (Eisenman 2013 [1992], 17).

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[54] See Deleuze and Guattari, *A Thousand Plateaus,* 450–1.

Eisenman sees Deleuze's concept developed in *The Fold* as such a way forward: 'for Deleuze, folded space articulates a new relationship between vertical and horizontal, figure and ground, inside and out – all structures articulated by traditional vision' (ibid., 19). Eisenman identifies Deleuze with the possibility of displacing the centrality of vision in architecture. The focal point of Deleuze's reconceptualization of relationality is directed to the specific example of folding as a concrete spatial system. Eisenman grasps the significance of folding to the subject position: 'Folding is a type of affective space which concerns those aspects that are not associated with the affective, that are more than reason, meaning and function' (ibid.).

In *Folding in Architecture,* Eisenman's urban concerns framed as the contextual relations between a building and its site, so prominent in post-deconstructivist discourse, is explored through specific design proposals and competitions with which Eisenman's office was engaged in the early 90s: *Rebstock master plan* (Frankfurt),[55] *Alteka Office building* (Tokyo), and *Center for the Arts, Emory University* (Atlanta), all of which are featured in the magazine. In *Folding in Time: The Singularity of Rebstock*, Deleuze's *The Fold* is brought up again as an alternative to a fixed notion of space, this time referring specifically to architecture's traditional alignment with the false perception of the Cartesian gridded space as a natural and neutral space, a position to which Eisenman critically refers as a 'condition of ideology' (Eisenman 2004a [1993], 40). Eisenman suggests replacing *subjectivity* with *singularity,* as the principal conception of the block in his master plan but as in Lynn's case, the gap between the stated and the designed is wide, because of the insufficient tools to realize a truly generative solution. In the *Alteka Office building*, Eisenman claims that 'The building evades its cartesian definition: not representing an essential form, but a form "becoming"' (ibid., 44).

Much like Lynn, Eisenman appreciates the overall ontology offered by Deleuze, which defies the centrality of the subject on all its faculties – mainly the cognitive and visual, which the central subject position entails. His projects respond to

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[55] Rebstock Park is a 5 million square foot housing and commercial development on the outskirts of Frankfurt; it was the winning entry in an international competition in 1992.

these challenges. However, and again like Lynn, Eisenman appreciates *folding* as a concept emphasizing *dynamism* and *continuity* rather than *difference*. There is no indication in his discussion of these two projects of a topological model and the parameters that directed the design. Eisenman's overall understanding of Deleuze's subversive concepts do not necessarily translate into a new architectural methodology.

Jeffrey Kipnis

The last text I refer to as part of *Folding in Architecture*'s mapping of novelty narratives is *Towards a New Architecture,* by the architectural critic and historian Jeffrey Kipnis. Kipnis is aware of the problematic recent history of novelty claims in architecture and hedges his title by acknowledging a sense of weariness in regard to announcing the *new* in architecture again. In this context, deconstructivism is analyzed as sharing the same characteristics as postmodernism, in the sense that they both destabilize existing forms. Kipnis frames this tendency in terms of a bigger cultural 'pathology, a kind of cultural *progeria,* that underlines our current withdrawal from the new' (Kipnis 2004 [1993], 58). The new architecture is formulated, argues Kipnis, in relation to Deleuze as well as in relation to scientific models, such as catastrophe theory and biological research. Unlike past reliance on these disciplines for inspiration, the new architecture refers to these disciplines because of their overall interest in morphogenesis, explained by Kipnis as 'the generation of a new form' which,

> However provocative and invaluable as resources these studies in philosophy or science are, it must be said that neither provide the impetus for a New Architecture, nor the particulars of its terms and conditions. Rather these have grown entirely out of architectural projects and developments within the discipline of architecture itself (ibid.).

This is an important distinction that acknowledges these new models as operating not only away from past styles, but also away from past architectural ontologies. The new studies in mathematics, philosophy and biology, claim Kipnis, support a new ordering system, which he terms generally as operating *morphogenesis* methodologies. Kipnis posits the turn to these new models against the background of postmodernism's ontological and methodological deficiency in accounting for diversity or, in other words, its socio-political

shortcomings: 'There are indications to suggest however, that collage is not able to sustain the heterogeneity architecture aspires to achieve' because 'the long-term effect of collage is to valorise a finite catalogue of elements and/or processes' (ibid., 58). As regards the political dimension of such practice, Kipnis is a vocal critic:

> the desire to engender a broadly empowering political space in respect of diversity and difference cannot be accomplished by a detailed cataloguing and specific enfranchisement of each of the species of differentiation that operate within a space. The process is not only economically and politically implausible, it is theoretically impossible (ibid.).

Before we move on to explore the specificity of Kipnis' methodological analysis, it is important to note the distinction he makes between deconstructivism and the new architecture, a distinction that he frames in terms of architecture of *DeFormation* as opposed to architecture of *InFormation*. By InFormation, Kipnis refers to deconstructivism,[56] while DeFormation is his title for the new architecture, which he defines as defying the fixity of stable alliances and promoting instead 'shifting affiliations' (ibid., 59). DeFormation differs from InFormation on the grounds of operating away from 'essentialist geometries' (ibid.). Deleuze's *The Fold* is mentioned in relation to DeFormation, but Kipnis distinguishes between the Baroque as a formal influence, which does not capture the extent of Deleuze's engagement with the period, versus a reference to Deleuze's 'generative effects of Leibniz's texts'. The former is mentioned as a form of applied philosophy, while the latter approach is discussed in conjunction with design strategies for projects featured in the magazine. The first example is Shridal and Zago's Alexandria Library competition entry.[57] Here, like Lynn and Eisenman, Kipnis struggles to acknowledge the gap between the ontological quest for operating a generative process and the lack of methodological strategies. The library project design process is a case of manual geometric manipulation, still within a formal, top-down regime, rather than a non-dualistic,

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[56] Kipnis follows MoMA's 1988 deconstructivist exhibition's narrative, and incudes under this umbrella the likes of Peter Eisenman, Frank Gehry, Daniel Libeskind, Rem Koolhass, Bernard Tschumi and Zaha Hadid. See Kipnis, 2004, 57. (Omitting Coop Himmelblau from the list of exhibitors.) See "Deconstructivist Architecture", MoMA, accessed 17 January 2017 https://www.moma.org/d/c/press_releases/W1siZiIsIjMyNzUwNiJdXQ.pdf?sha=c44f26c8dd8bf 1f2.)

[57] Kipnis, *Towards a New Architecture*, 2004[1993], 61.

non-essentialist relationality. Another example Kipnis puts forward is Eisenman's convention centre, Columbus. Kipnis affirms Eisenman's 'abstract monolith free of explicit reference' as a methodology not only defining DeFormation, but also linked to Deleuze on the basis of a design approach to site relations that are not a predetermined relationship 'but effects that flow from the intrinsic formal, topological or spatial character of the design' (ibid., 61).

The novel aspect about DeFormation is therefore a new relationality forged between the site and the intervention, relationality that Kipnis terms *affiliation,* defined as:

> provisional, ad hoc links that are made with secondary contingencies that exist within the site or extended context. Rather than reinforcing the dominant modes of the site, therefore, affiliations amplify suppressed or minor organisations that also operate within the site, thereby re-configuring the context into a new coherence (ibid.).

Such relationality replaces the representational architectural system.[58] In this respect, Kipnis' overall direction corresponds with Deleuze's non-representational concepts, while not necessarily stemming from a specific methodology in *The Fold.*

The account given by Kipnis does not include mathematical models, and in the only case in the publication where such tools were put to use – that of the roof to Shoei Yoh's Odawara Sports Complex – Kipnis finds the parameters used for designing the roof insufficiently contingent or, in other words, sharing a direct relationality to the site. This approach seems to oppose one of DeFormation's main principles – *open-endedness* – while the prosaic and direct parameters in relation to the site deem to breach that becoming. In this context, Kipnis quotes what he perceived as a grim prediction by Lynn: 'As Greg Lynn quipped, "soon we'll be designing form based on the air turbulence generated by pedestrians walking near the building"' (ibid., 63). It is the degree of alignment rather than affiliation in such scenarios that Kipnis finds significant. It is the predetermined

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[58] Which by contrast, operates through 'manifest, latent typological/morphological diagrams, prevailing architectural language, material, detailing or the like, and incorporate some or all of these influences in a design, often by collage', as Kipnis explains the traditional approach to relationality. Ibid.

relationality that he finds in breach from DeFormation's methodology and with it the ontological significance of such direct relationality, as he concludes:

> the test of whether or not the results are DeFormative, therefore, will not depend on the success of the project in embodying responses to those influences, but on the other contingent effects it continuously generates (ibid.).

This statement is as close as we get to a Deleuzian architectural ontology, which defies empiricism, representation and causality; it is a post-humanistic approach par excellence, however, without the means to achieve such an open-ended approach.

To conclude, in 1993, these new architectures, bound by Lynn into one volume, all shared the need to reposition themselves outside of chronos, but not in a modernist way of elimination, or in a postmodernist way of negating through formal inclusion/ exclusion of past styles. Both these alternatives enact dualistic mechanisms. Rather, this new architecture strives for a *new relationality*, which they found in Deleuze's general concept and the mathematical figuration he brings to the fore in *The Fold*. At the same time, I showed an emerging tension between the two ontologies in the work of Lynn, Eisenman and Kipnis, a tension between framing their own novelty as stemming from Deleuze's ordering system, the new relationality and simultaneously emphasizing the formal, literal aspect of this relationality (folding) rather than its mechanism (the differential calculus). What these architects in the early 90s cannot yet articulate is the process to materialize Deleuze's influenced non-essentialist, open-ended ontologies aiming to reconceptualize the architectural design process by means other than formal representation of urban heterogenetic conditions, these means becomes attainable with the development do digital tools available to the architectural world in the 2000s.[59] What they articulate, however, are the trajectories, the ontologies in themselves, which I define as post-formal at this stage – in the sense that it is the interaction between various entities, without a

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[59] Kipnis lists several techniques in pursuit of a posteriori affiliative techniques, of which computational aided techniques are only one option. The full list includes: 'camouflage methods, experimenting with computer "morphing" programs that smoothly transform one figure into another, or employing topological meshing techniques such as splines, NURBS, etc.' Kipnis, 63.

single operator, a centre, an eye or a mind controlling their interaction, for which they all strive.

2004 – folding in architecture narration; reformulating the post-human in terms of a new style

I return to Lynn and place his two texts (1993, 2004) side by side to account for the gaps between the original raw methodological moments and the 2004 narration. In his new forward to the 2004 reprint, presenting an overview of the themes and directions being developed by the original projects and theories, ten years later, Lynn acknowledges the two main influences directing the new architecture of the 90s. He reiterates folding as a reaction to postmodernism's divide and control methodologies; reflecting back on the historical context. The new architecture, claims Lynn, was a shift towards 'the spatial, artistic and mathematical models of Deleuze, Foucault, Whitehead and even, to some degree, Lacan' (Lynn 2004b, 9), out of which Lynn acknowledges '*the Deleuzian focus on spatial models,* most of which were derived from Leibniz's monadology' (ibid., my emhasis). In conjunction with the trickling of Deleuze's 'spatial models' to the architecture of the 90s, Lynn cites the 'scientific models of complexity, initially those derived from the work of René Thom and later those of the Santa Fe institute' (ibid.).

> The combination of the discovery, for the first time by architects, of a 300-year-old mathematical and spatial invention, that is the calculus, and the introduction of a new cosmological and scientific model of emergence, chaos and complexity, made for an extremely provocative and incoherent moment in architectural experimentation (ibid.).

At the same time, Lynn elaborates on the importance of Deleuze to the formation of his own architectural methodology, claiming in hindsight that 'For me, *it is calculus* that was the subject of the issue […] *The loss of the module in favour of the infinitesimal component and the displacement of fragmentary collage* by the intensive whole are the legacy of the introduction of calculus' (ibid., 11, my emphasis). Moreover, Lynn argues that 'The focus, in the issue, on compositional, organisational, visual and material sensibilities, rather than on theories of digital design, was only possible at that moment before the digital waves of software-

sponsored discourse that soon swept over the field' (ibid., 10), which is made possible, he further argues, because in the absence of digital tools.

However, Deleuze's calculus is not mentioned by Lynn in the 1993 text. Calculus refers to a new process, not articulated yet in the 1993 *Architectural Design* (AD), nor is it present in Lynn's only project included in the magazine. A piece published in *Assemblage* in 1992, 'Multiplicitous and Inorganic Bodies' by Lynn, may shed light on these conflicting claims. As early as 1992, and before he is introduced to *The Fold*, Lynn speaks against the notion of a standard in architectural production and against the notion of typology, while introducing two Deleuzian concepts, one of which is an early one, that of *multiplicity*, posited against the notion of fixed identity. Lynn frames this notion in architectural terms as explains the impossibility of separating interior and exterior. The second concept Lynn refers to in his text originates from *A Thousand Plateaus* and is a rejection of the notion of close linear phyla, or a close typology of forms. Lynn discusses these alternative, transient associations not only as general concepts, but also as sources of a new architectural vocabulary. This 1992 text, when placed in the context of *Folding in Architecture*, points to a trajectory present in Lynn's projects before he was introduced to the 'spatial models' of *The Fold.* The above-mentioned examples trace an active field of references that frame an intellectual quest towards an architectural practice that operates an architectural model of non-dualistic relationality. This model can be summed up as a non-representational model.

Based on the close reading above, the shift to a calculus-based architecture is still a trajectory in 1993, and the only mathematical model available to the generation of the early 90s is that of René Thom. Vocabulary plays an important role here for, despite the rich references and the general understanding of these alternative means of differentiation inspired by Deleuze, when it comes to the articulation of these notions as part of an architectural discussion, Lynn zigzags back and forth from formal appreciation of the new architecture to its function as a new ordering system that bypasses centuries-old representational techniques in architecture. He fluctuates between an understanding of Deleuze's concept as supporting such quests and a reductionist approach to *The Fold* as a

spatial model mentioned above. His 2004 articulation of the new theory as a theory of *intricacy* further supports this analysis, because it is not so much the conditions or the processes that lead to differentiation by calculus, which is the focus of Deleuze in *The Fold*,[60] but rather the unifying formal effect the system accomplishes from an architectural point of view. That is to say that the focal point is not on difference but rather on spatial expression that smooth it up, which reduces Deleuze's models to formal terms. Deleuze's system is of interest to Lynn as a formal by-product and not because of the relationality that leads to it, nor does he comment on the significance of such a shift in terms of the architect's position, which such an enquiry will call for. I attribute the second reduction to Carpo's 2004 narrative, as I discuss in the next section.

All the above-mentioned texts and projects expose a technical gap between the ontological direction and the methodology available, at that stage of architectural thought, to support the aspired shift to topologically driven research. This point in technical evolution arrives towards the end of the millennium, at which point the theory, which could not be actualized by the clunky means of the early 90s was left to one side, Deleuze's concepts included. Helping in this formal shift is Mario Carpo's 2004 historical overview, which offered the official narration to the tendencies forming in the previous decade. Prior to being computerized, these principles struggled to find the design methodology that would keep them afloat, for the materiality at this early age of digital architecture was the traditional architectural elements of the building and the manual adjacencies and formalities, that would come to an abrupt end with the introduction of 3D generative architectural tools.

Carpo's formal narrative
An outsider to the original publication, Carpo contributes an historical overview of the original 1993 publication.[61] In *Ten Years of Folding*, Mario Carpo endorses

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[60] I develop this argument in the next chapter.
[61] The architectural historian Mario Carpo is a voice of a majoritarian history of digital architecture. He is immersed in the digital milieu through his many publications on digital history. His essays have framed the official historiography of the digital emergence, from 2004 *Folding in Architecture*, Carpo's pivotal role as the storyteller of the digital was established in the following two additions of AD closing each decade, 2004's *Ten Years of Folding*, which was followed ten years later by an edited book, published again by Wiley and entitled *Twenty years of digital de*sign (2013). I refer to these two texts in the first part of this cartography, while the

the centrality of *Folding in Architecture* as underpinning the development of digital architecture (2004). Carpo frames the widespread influence of the publication as a 'catalyst' for a shift in architectural thinking and production: 'as the quintessential architectural embodiment of the new digital technologies that were booming at the time' (Carpo 2004, 14). The architects featured in the publication are positioned as pioneers, not only of folding, but also of the digital culture to come.

No paragraph better captures Carpo's overall 2004 narrative of novelty in digital architecture than the following one, and I quote it in its entirety:

> an original quest for formal continuity in architecture, born in part as a reaction against the deconstructivist cult of the fracture, ran into the computer revolution of the mid-nineties and turned into a theory of mathematical continuity. By a quirk of history a philosophical text by Gilles Deleuze accompanied, fertilized and at times catalyzed each of the different stages of these processes. Without this preexisting pursuit of continuity in architectural forms and processes, of which the causes must be found in cultural and societal desires, computers in the nineties would most likely not have inspired any new geometry of forms. Likewise, without computers this culture demand for continuity in the making of forms would soon have petered out and disappeared from our visual landscape. The story of folding […] once again suggest that only a dialectical interaction – a feedback loop of sorts – between technology and society can bring about technical and social change: including, in this case, change in architectural form (ibid., 16).

Carpo's summation of digital novelty distances itself from the conceptions of novelty expressed by Lynn, Eisenman and Kipnis because his account eliminates the ontological tensions present in their narratives of novelty, which I identify in their position towards *The Fold.* Such elimination has a flattening, reductive effect on their theories, theories that on the one hand emphasize formal

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publication that I refer to in the second part of this cartography is a 2011 publication from MIT Press, *The Alphabet and the Algorithm*, in which Carpo lays out his post-projective theory of digital architecture. Carpo is currently a professor of architectural history and theory at the Bartlett School of Architecture and directs a new Master's program: MRes Architecture and Digital Theory. His theoretical background includes the history of modernity in architecture. He dedicated his first publications to the codification and standardization of architecture as a profession in the fifteenth century, narrating the shift from the culture of variation of the pre-modern culture to a culture of sameness. The shift from modernity to the digital age is being framed as a reversal of this early history.

continuity while at the same time channelling the ontological shift underlying this continuity into their own architectural methodologies. Carpo's oversight of this complexity eliminates from the official narrative their vocal motivation to question the architectural conventions and traditions, especially the centrality of vision as that which orders the architectural processes and products, and the reliance on past formal vocabulary in addressing urban complexity and programmatic and cultural heterogeneity. Moreover, Carpo presents the discursive rawness of *Folding in Architecture* as incoherent and outdated.

Positing the new architecture in relation to postmodernism and especially to deconstructivism is a departure point for most of the works in the publication. Carpo follows on this historiographic direction, but, in retrospect, he positioned the novelty of the new architecture in terms of a formal reaction to postmodernism's tendency to extenuate complexity and contradiction, a reaction against the angularity of the 90s' deconstructivist era – a stylistic matter, he explains – and, moreover, as part of a cyclical process, architecture's formal tendency to swing from the angular to the curvilinear.[62] Curvilinearity defines the change as departing from the engagement of the American avant-garde with Deleuze's *The Fold* framed by Carpo as a 'hermeneutic of continuity', further explained by him as:

> a unifying figure whereby different segments and planes are joined and merge in continuous lines and volumes […] both the emblem and the object of Deleuze's discourse. Folds avoid fractures, overlay gaps, interpolate (Carpo 2004, 14).

The reduction of Deleuze's *The Fold* into a theory of formal continuity hinders Carpo's narration and prevents him from answering his own enquiry: 'How can fractures, ridges and edges represent formal continuity? Where are the folds?' (ibid.). Nor does his analysis allow him to account for the way the 90s began angular and ended up curvilinear. Mistaking the movement itself as the *raison d'être* of the new architecture dislocates Lynn, Eisenman and Kipnis's main arguments.

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[62] See Mario Carpo, "Ten Years of Folding", in *Folding in Architecture*, 14.

It is true that the American architectural avant-garde was saturated by the various outputs of stylistic fragmentation that succeeded modernism; from that standpoint, postmodernism in architecture, from Venturi's *Complexity and Contradiction* and on to Libeskind's deconstruction, strove for a different relationality to the standardized, monolithic practices in high modernism. But what modernism and postmodernism share is dualistic relationality, a formal one, and by that I mean appropriated in relation to a formal standard or a precedent, in the relation of architecture either to a site or within it, as the rule that arranges the massing and façades of a specific intervention. Deleuze, as well as other complexity theories (catastrophe theory specifically) offered the architects and theorists taking part in *Folding in Architecture* an alternative non-dualistic ontology that bypasses both architectural history and its methodology. This significance of the shift was acknowledged by these architects, albeit at times inadvertently, but it was not picked up by Carpo. Yes, these thinkers-architects were catalyzed by the polemical fatigue of modernism and postmodernism, but that was not their sole motivation. In the case of all three, it was the insufficiency of past models to respond to heterogeneity and complexity. In the case of modernism, it was disillusionment with the homogeneity project that proceeded by applying a standard, a module to all – resulting in the purge of difference. In the case of postmodernism, the subversive, combative, dialectical representation of those differences, positioning itself as the negative image of modernism, was not the harbourer of novelty, nor of complexity and, as Kipnis pointed out, relied on a finite pool of historical solutions. This dialectical system came to a standstill. It is the epistemic inability of architecture to account for the new temporalities introduced by the media/ film/ telecommunication revolutions of the 80s, a shift towards a new capitalist age, known as neoliberalism, which enticed an interest in post-humanistic philosophical theories as well as in complexity theory. *Folding in Architecture* captures these quests in their raw ontological moment, which from their architectural standpoint entailed questioning the modernist and postmodernist (the modern) dualistic relations between vision and architectural form, building and site – the pillars of a representational, semiotic system.

Carpo's homogenizing text of 2004 not only erased post-representational
tendencies from the canon, but also erased a materialist, feminist, sexually
differentiated reading of *The Fold* and its relevance to architecture. Karen Burns
notes that Claire Robinson's essay, although part of the original and the reprint,
is missing from Lynn's introduction as well as from Carpo's historical overview.[63]
What is the significance of Robinson's text? It is insistence on discontinuity that
is unique to her conceptualization of Deleuze's *Fold*, especially in the context of
the 1993 publication. Robinson's text is a quest for difference – in her case,
sexual difference. Irigaray's fluid figurations set the tone of the text but, if we
look beyond them, we find two feminist conceptualizations of *The Fold* and
architecture that are important to my thesis. The first is the materialization of
the fold in general and the second is the insistence that the singular points are
points of otherness. Taking René Thom's catastrophe theory as a departure
point, Robinson, much like Lynn and Eisenman, finds his theory relevant to
architecture because 'Topology becomes a geometry of reconciliation between
building and ground, logos and noise' but, unlike Lynn and Eisenman, Robinson
identifies the importance of this new relationality not in continuity, but rather in
discontinuity, or in other words, in *singularity*:

> Inherent in his [Thom's] work of identifying and naming mathematically
> singular discontinuities is a concern for the phenomenological otherness
> inherent in the resultant geometries. This otherness has a materiality. To
> take the fold as solely formal gesture is the same as allowing its
> materiality to be evacuated (C. Robinson 2004 [1993], 80).

Quoting Nicola Brossard's *Picture Theory*, Robinson elaborates: 'The architecture
of the fold is one of becoming; one of a specific gestational process. If the task is
to define or theorize the fold as place in architecture, this must certainly be
within place (entation)' (ibid., 81). Pointing to the relationality and porosity of
the architecture 'site', the continuity and entanglement of the elements. The
singularity is in the walls (the placental wall in Robinson's metaphor) 'That one

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[63] This is part of a wider claim made by Burns on a culture of omission of Deleuze's
theory from the same canon of architectural history, but, in her case, omission of sexual
difference. She analyzes this omission with Deleuze's work becoming mainstream. I maintain that
this forgetfulness is systematic and deliberate. See, Karen Burn, "Becomings: Architecture,
Feminism, Deleuze – Before and After the Fold", in *Deleuze and Architecture*, ed. Hélène Frichot et
al. (Edinburgh: Edinburgh University Press, 2013), 16.

finds local conditions of heterogeneous spatial varieties. The wall locally becomes an intelligent and responsive membrane with innate capacities to direct the flow of space; the separation and connection between discrete places' (ibid.). It is the folding together of the two worlds that we are concerned with.

Robinson voices a similar tension to the one I have pointed to throughout this chapter – that the fold cannot be equated with a pursuit of new forms, but rather with a pursuit of a new ordering system, or relationality system, which I have nevertheless identified with the tone-setters of this period, with Lynn, Eisenman and Kipnis. What Robinson points to is the nomadic quality of Deleuze's concept that has been evacuated from their projects, the material aspect, the embodied and embedded insistence on feminist, nomadic theory, which introduces social political questions. It is here that I posit the distinction between post-formal practice, which is shared by most postmodern architectural practices, and post-human ones, which are nomadic as well as being post-representational. I develop this point further in the closing section of this chapter.

Not unlike Johnson and Hitchcock's 1932 *The International Style* exhibition at the MoMA, which inflated the complexity of the modernist avant-garde claims to novelty on the grounds of an ontological shift and repositioned it as a new style, a formal kit of solutions, so does Carpo's narrative.[64] The 1993 discussions of the new architecture as revolutionizing core architectural assumptions and approaches, captured briefly by Lynn, faded away in the 2004 retelling of the narrative. The indecisive stand presented by the architects and theorists themselves in regard to their position of novelty, as well as the polemics-averse intellectual context at the time are 'internal' catalysts in this direction.[65]

On non-criticality
I discuss *The Fold* at length in the next chapter, but at this point I would like to stress that Deleuze's theory, which offers a recount of Leibniz' seventeenth-century philosophy on monadology, operates what we now call a post-

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[64] As we shall see, in 2011 Carpo reverses his position to claim the new architecture as operating away from modernity's identical system, as I discuss below, but in 2004 he omits any post-humanistic hue from the narrative.

[65] The second, 'external', catalyst I show in the second novelty narrative, *the algorithm* to be the digital technology itself that became available towards the end of the millennium.

humanistic world, where novelty is a result of affectual inputs emerging from differential relations. Such system overrides the need for a standard; moreover, it undoes the centrality of cognition. From an architectural point of view, that entails replacing an entire aesthetic architectural system based on representation supported by a human-subject centrality. Such system unfolds a formal response not on the basis of a humanistic approach to a site, channelled via cognition and vision, both imply a central fixed human (an architect). Deleuze's calculus is a response to the either/ or approach, in the architectural context, either complexity or harmony, which always responds to or stems from a reaction to a standard. The differential calculus is a mathematical approach that generates relationality not stemming from a standard but from relations themselves.

My reading of Deleuze, including *Difference and Repetition* as well as *The Fold* and *A Thousand Plateaus,* leads me to position Deleuze's interest in *The Fold* as well as his interest in Leibniz as an ontological and epistemological shift away from fixed identities. It is correct that this system of relating should not be seen as an oppositional system, but neither should it be understood as a system of homogeneity, nor as a non-critical system. Mistaking the one for the other leads some historians to equate curvilinearity with a post-theoretical stand. For example, the architectural critic and historian Douglas Spencer points to a generational aversion towards ideological polemics, known as the emergence of the 'end of history' paradigm, established towards the turn of the twentieth century and against the backdrop of postmodernism. Such an 'end of criticality' paradigm, claims Spencer, was facilitated by the smooth overtake of the new architectural curve which sidestepped socio-political complexity. It is interesting to note that Spencer associates this theoretical climate with the 'Eisenman boys':

> Where Deleuzism in architecture originally undertook, then, to establish its autonomy from the linguistically oriented concerns of poststructuralism, it subsequently sought to distance itself too, as part of its affirmation of the new – indeed, affirmation of affirmation – from any obligation to engage with *critique.* Through its alliance with the post-critical position emerging, around the same time, in US architectural discourse – marked by the publication of Robot Somol and Sarah Whiting's 'Notes Around the Doppler Effect and Other Moods of

Modernism' in the journal *Perspecta* in 2002 – it articulated its opposition to critique as a matter both extrinsic to the 'proper' concerns of architecture, and as a counterproductive form of 'negativity' (Spencer 2012, 10).

Spencer's notion of the affirmative is misconceived. The conflation of affirmation with non-criticality characterizes the narratives of the first generation of digital discourse, despite the manifestly nuanced approach of Lynn, Eisenman and Kipnis and their vocal social critique of deconstructivism. At the same time, Lynn conflates affirmation with *pliancy*, Eisenman frames it with *weak form* and Kipnis by practice of *affiliation* – all of which point to my earlier point concerning the importance of *continuity* to their discourse as practice that describes the relationality in formal means rather than deferring to the mechanism of the relationality itself. Affirmation in the context of Deleuze is a reiteration of a non-dualist system. In the case of *The Fold,* such a system is enabled by the differential calculus, and later by topological geometry.[66]

This conflated state of the discourse and its deep roots in Deleuze's texts is acknowledged by Bernard Cache. While the history of *The objectile,*[67] reintroduced to the architectural world via *The Fold,*[68] is a well-documented anecdote in the history of digital history, less familiar is Cache's retrospective cautiousness in regard to the role he himself played in the codification of Deleuze's theory as formal theory.

> We have to admit that we contributed in a small way to this misunderstanding, since the introduction of computers into our discipline was like opening up a Pandora's box. Despite all our precautions – our insistence on the need to think through the means and relations of production; our attempts to tie these variable curved surfaces and sloping planes to historical precedents such as the Baroque of Leibniz […] it has become all too clear that the digital in architecture is often reduced to a

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[66] See Cartography 2, part 1, for the mathematical history of these concepts.

[67] '"Objectile"' was the name given by Gilles Deleuze to the research I am carrying out with Patrick Beaucé and others into the development of an industrial means of producing non-standard objects. By this, I mean objects that are repeatable variations of a theme, such as a family of curves declining the same mathematical model; objects in flux.' See Bernard Cache, "Objectile: the Pursuit of Philosophy by Other Means", in *Projectiles*, ed. by Bernard Cache (London: AA Publication, Architecture Words 6, 2011), 20.

[68] See Deleuze, *The Fold,* 20.

plaything for adolescents who dream of constructing a beautiful object, whatever the financial or social cost (Cache 2011, 15–6).

The focus on the *objectile* by the 90s' generation sidetracked attention towards the processes of differentiation as the new ontology, which is the basis for an affirmative practice. The rule of the *objectile* as a formal and non-critical artifact has dispersed the Deleuzian non-dialectical ontology, which explores differing processes that cannot be achieved in an architectural context without considering the social and economic parameters that are being placed in relation.

Narrative 2: Non-Standard Architecture
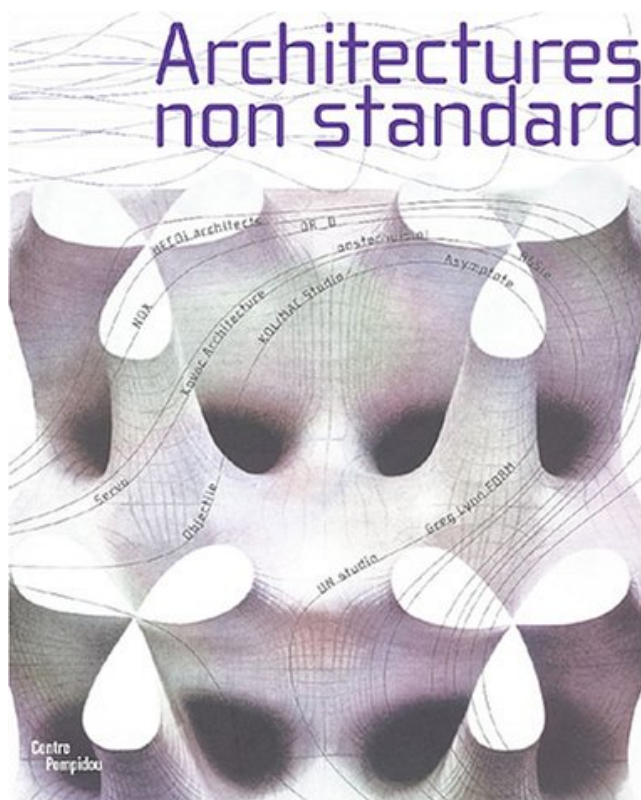
Figure 4: Architectures Non Standard publication, 2003–04, Paris, book cover image

From December 2003 to March 2004 the Pompidou Centre in Paris held an exhibition dedicated to digital architecture. The exhibition was curated by Frédéric Migayrou with Zeynep Mennan, under the title: *Architectures Non-Standard*, this exhibition frames the digital projects curated as epitomizing the shift to a calculated architecture, defined as rational architecture placed as an

alternative to formal architecture. This exhibition narrative of novelty therefore emphasis the mathematical processes framing these architectures, namely the topological mathematical processes and not digital tools per se. This narrative inadvertently redefines architectural production in means other than representational.[69]

> The aim is not merely to present examples of digital or virtual architecture, which deal with questions of representation (such as virtuality and hyperspace), but rather to highlight current modifications to the industrialization of architecture. The widespread use of application programs based on algorithmic systems presupposes changes in design and production tools. 'Non-Standard Architectures' is a reflection on the language of architecture and its field of application, based on the exploitation of digital elements (Architectures Non-Standard, Communiqué de Presse 2004).

The exhibition featured the work of 12 architectural practices whose work ranged from the late 90s to the early 2000s.[70] The narrative of the digital, as it emerges from the exhibition, is another example of a repositioning of novelty discussions away from the domain of the formal, and therefore, although inadvertently, within post-humanistic reach, as the mathematics model these architectural examples rely on support of a non-representational and generative processes. Migayrou isolates the mathematical discussion from Deleuze, or from folding practices, and claims an alternative genealogy, reconnecting the calculus to current mathematical history and to the history of architecture, a history that is seldom told.

Migayrou's curation contests *folding* narration that claims the digital as another phase in a postmodern debate and, as such, still in the modernist and formal tradition. It presents a shift from the American historiography of digital

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[69] In this section I refer both to the exhibition catalogue (which was never translated into English) as well as to a lecture Migayrou gave in 2009 at the AA, where he retells the story of the exhibition "Architectural Mathesis Frédéric Migayrou's lecture." (26 November 2009), last accessed June 2016. http://www.aaschool.ac.uk//VIDEO/lecture.php?ID=1131.

[70] These included: Asymptote (Hani Rashid & Lisa Anne Couture, USA), dECOi Architects (Mark Goulthrope, France, USA, UK), DR_D (Dagmar Richter, USA, Germany), Greg Lynn FORM (Greg Lynn, USA), KOL/MAC Studio (Sultan Kolatan & William MacDonald, USA), Kovac Architecture (Tom Kovac, Australia), NOX (Lars Spuybroek, Holland), Objectile (Bernard Cache & Patrick Beaucé, France), oosterhuis.nl (Kas Ooserhuis & Ilona Lenard, Holland), R&Sie (Françoise Roche & Stephanie Lavaux, France), Servo (David Erdman, Marcelyn Gow, Ulrika Karlsson, Chris Perry, Switzerland, Sweden, USA), UN Studio (Ben van Berkel & Caroline Bos, Holland).

architecture presented in *Folding in Architecture*, and by AD magazine in general, by connecting the digital revolution in architecture to non-standard mathematics and to alternative history of architecture, which runs parallel to the modernist functional and rational histories. Migayrou's curation looks back to the history of art and architecture in search for precedence of pre-digital mathematized space, specifically using either differential calculus-based methodologies or the later *non-standard* analysis for the production of architectural curvatures. This alternative history is supported by a wealth of architectural references that go back as far as the beginning of the twentieth century, with the first attempt to produce topologically mathematized, calculated form.

The exhibited digital practices were complemented by what Migayrou refers to as 'the ribbon', a continuous plaster fold that wrapped around the exhibition's open space, displaying numerous art and architecture images positioned as historical references to the use of non-standard mathematics in the production of spaces, a historical evidence for the narrative of the exhibition. In his 2009 AA lecture, Migayrou presented the exhibited models of digital architecture in passing while dedicating the main bulk of the talk to mapping the intellectual, mathematical and philosophical genealogy referenced as part of the material displayed on the ribbon. Deleuze played a marginal role in this architectural and artistic history, as one of many inspirations deriving from mathematics, biology, computation and philosophy, all of which have in common a reworking of complexity theory. This genealogy positions the roots of digital architecture with historical attempts to approach spatiality not framed by predetermined formal methods, but as emergent spatiality. Migayrou presents this genealogy against the story of the digital told by the 'Eisenman Boys' (referring specifically to Kwinter, Kipnis and DeLanda) who are claimed to frame the emerging folding techniques as an extension to the prevailing deconstruction thinking practised in America as part of a migration of ideas from France to the USA, where they have become 'an orthodoxy', and back to frame a new paradigm, arguing that this is still the case these days with platforms such as *Architectural Design*.[71]

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[71] See François Cusset, *French Theory, How Foucault, Derrida, Deleuze, & Co. Transformed the Intellectual Life of the United States* (Minneapolis: University of Minnesota Press, 2008
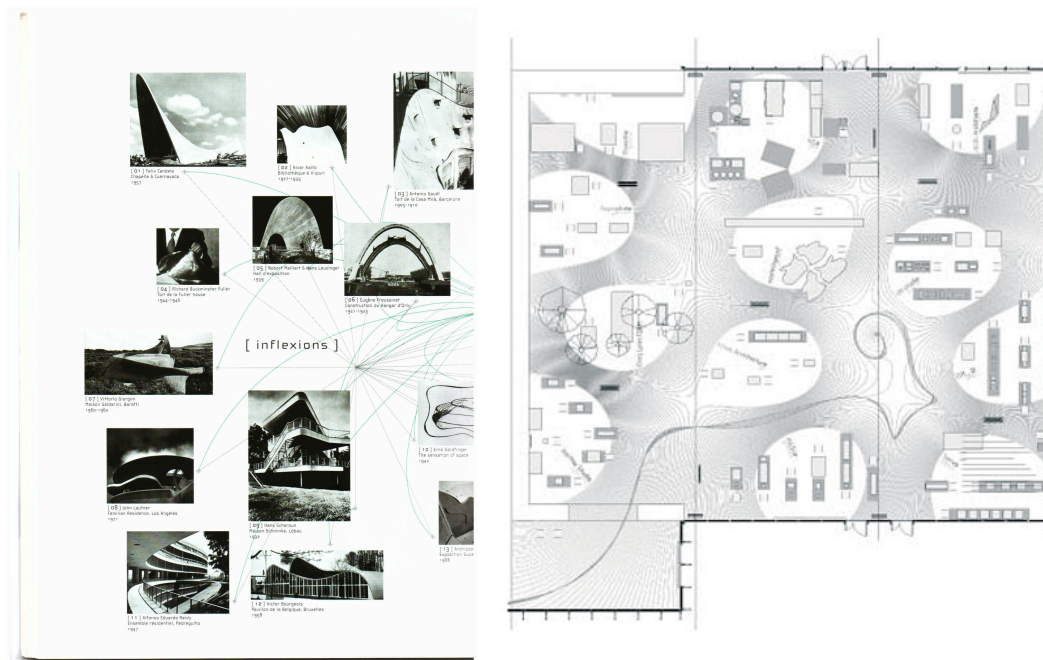
Figure 5 (left): Non-Standard Architecture, architectural references displayed on the 'ribbon'
Figure 6 (right): Non-Standard Architecture, exhibition plan by Philippe Morrel

According to this narration, novelty is not a product of digital platforms. Moreover, Migayrou clearly differentiates between two types of digital architecture production: the first type is digital architecture produced mathematically, while relying on non-standard analysis, which creates 'rationalized' mathematical space, to which he gives the example of the exhibition space itself designed by Philippe Morel, a non-standard space.[72] However, digital production of architecture can still be produced formally, Migayrou explains, such is the example of Frank Gehry's early work, that reverses the process and assigns complexity in retrospect to formally produced forms that are then scanned while using CATIA software.[73]

[2003]) for an elaboration on the migration of French structuralism and post-structuralism across the Atlantic.

[72] Migayrou retells the story behind its creation, which entaled collaboration with the Poincaré institute. Morel came up with a way to divide the space into 'a rational yet non linear space', using for the first time in architectural application software called *Mathematica*, which was invented by Wolfram. See "Architectural Mathesis Frédéric Migayrou's lecture." (26 November 2009).

[73] See "Project 1: Lewis Residence, Frank Gehry & Associates, Inc." in *Archeology of the digital*, edited by Greg Lynn (Berlin/ Montréal: Canadian Centre for Architecture and Sternberg Press, 2013), 174–9, for a detailed explanation of Gehry's process in designing the Guggenheim in Bilbao.

The exhibition title, Migayrou explains in his lecture, deliberately denotes the understanding of *Non Standard* in two different orders, reiterating the gap between the ways this term is appropriated and understood differently in a mathematical context as opposed to its literal meaning in a general context. As a mathematical concept, non-standard refers to an analysis discovered in the 1960s, by the mathematician Abraham Robinson. Non-standard, claims Migayrou, is the realization, in mathematical terms, of the Leibnizian intuition that theorizes an infinitesimal aspect to calculus.[74] According to Migayrou, the infinitesimal calculus could not have been realized without Robinson's discovery of the non-standard as he connects catastrophe theory, cellular automata, the Voronoi diagram and more to Robinson's discovery. Migayrou's analysis, his mathematical and historical account takes us through the lineage of non-standard analysis initiated by Robinson and realized through his colleagues and students, including Mandelbrot (a mathematician who is most associated with fractal theory), through to his other student René Thom. Migayrou's account contributes academic engagement in scientific history, often lacking in the architectural theories of his contemporaries.

It is interesting to note that *Architectural Design* magazine did not feature the exhibition, and only addressed it in the form of a short review by Mario Carpo (2004).[75] In the same manner that Carpo had exonerated *Folding in Architecture* from ontological tension between humanistic and post-humanistic tradition, he evaded a reflection on non-standard in any way other than the purely architectural, as an anti-standard mode of fabrication, that of serial production of non-identical parts, which is not mathematically informed but rather formally appreciated. This narrow understanding of *non-standard* led Carpo to conclude that:

> on the basis of the visual evidence provided by the exhibition, most conspicuously by the display of historical images, many visitors may have

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[74] I develop the significance of this mathematical leap as well as the history of the mathematical dispute between the adherents of finite and infinite calculus in Cartography 2, part 1.

[75] Mario Carpo, "Review: Architectures Non Standard by Frédéric Migayrou, Zeynep Mennan", *Journal of the Society of Architectural Historians* 64, no. 2 (2005): 234–5. doi:10.o st2307/25068146.

left the Galerie Sud of the Centre Pompidou persuaded that 'non-standard,' when referring to architecture, simply means all architecture that is, was or ever will be, round (Carpo 2005, 234).

Carpo has mistaken the overarching narrative to be a formal one:

> Yet there are many ways to define what a non-standard form is, and there is no consensus on the matter. Additionally, if the focus shifts from the way of making things to the way things look, the discussion of non-standard architecture runs into some snags, and it may become confusing (ibid.).

Carpo misunderstood the mathematical theory that relates all the images and the projects in the exhibition as being 'anti-standard' formal precedence, while Migayrou and Mennan were pointing to the topological models that led to a non-standard mathematical analysis.[76] Once again Carpo replaces an ontological argument with its formal traits.

My reservation from Migayrou's narration is on a different ground altogether. I would like to point here to the correspondence he renders between non-standard analysis and Leibniz's calculus – contrary to Migayrou's assertion, non-standard analysis is not the realization of Leibniz's infinitesimal calculus, and this is not just a minor point. Deleuze himself expresses the problematics in the non-standard to realize the infinitesimal at the last chapter of *The Fold,* a topic, which I expand on in the next chapter. At this point suffice it to say that Robinson's analysis solves the infinitesimal dispute in a way that does not respect the differential calculus as a mechanism that produces difference because it includes all eventualities in the calculation, as such it erases difference altogether.[77] Migayrou further asserts that Deleuze's calculus could not have been realized fully while remaining attached to Leibniz and to Baroque spatiality. In cartography 2, part 1, I show that Deleuze's ontology was never limited to a mathematical boundary. Highlighting the mathematical divorced from an entire philosophical ontology beginning with Leibniz has offered an alternative to the

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[76] See Migayrou's lecture as well as Cartography 2, part 1, for a discussion of non-standard as a mathematical analysis.

[77] As I show in the next chapter, Leibniz's infinitesimal is the condition of each monad; however, each monad realizes only a finite angle out of the infinite set of possibilities as a derivative of its affective capacity.

Newtonian tradition, but at the same time, without the ontological aspect such history maintains a positivist hue, which roots it back in the scientific tradition of the Enlightenment. It also means that, according to Migayrou's reading, novelty in the digital is attributed a priori to any topologically mathematized space. [78]

This leads me to the next shortcoming of Migayrou's theory, the submission of the post-formal and non-representational mathematical systems, which are not in the realm of human cognition, back into humanist ontology that centres on 'rationality'. Understanding calculus-based analysis as producing a rational world manifests to a positivist and instrumental ontology behind the consideration of post-formal processes, and attests to another example of a narrative where post-humanist epistemology operates within the realm of humanist ontology.

Narrative 3: The Algorithm

The first decade of the twenty-first century witnessed a plethora of architectural digital platforms. Mark Burry (2011) has named 2002 the year when many of his colleagues began experimenting with scripting architecture and as the time 'when several packages combined thrilling levels of 3D modelling with associated scripting languages, principally Maya (using Maya Embedded Language (MEL) scripting), and Rhino 3D using Rhino VB' (Burry 2011, 37). 2001 was the year that the scripting software *Processing* was introduced, while Rhino *Grasshopper* software was first introduced only in 2007. This is a period of consolidation of digitality that specifically concerns itself with the production of architecture and with the algorithm as the main novelty narrative. It is no surprise then that this new novelty narrative emerging in the second half of the 2000s shifts the discursive arena to the digital realm per se. The articulation of novelty as embedded in a shift to post-formal practice we witness in the previous two narratives was lacking a defined digital epistemology, emphasizing pre-

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[78] This question refers mainly to a dispute between the infinite and finite interpretations of calculus. My interest in highlighting this dispute as relevant to the history of digital architecture lies in the ontological implication of these options on the possibility of developing an affirmative relationality. See cartography 2, part 1.

digital and predominantly mathematical processes. Both these attempts at rendering post-formal practice operate at the same time on the premise of humanist criteria; form and rationality that centre on two major faculties in the construction of Western concepts of subjectivity, vision and cognition. Digital architecture of the second half of the 2000s shifts to articulate the algorithm as the vanguard of novelty of the digital.[79] The algorithm is still within a post-representational trajectory; however, it assigns a specific epistemology and digital methodologies missing so far from the discourse. This part of the cartography investigates the terms of its articulation.

The two digital architecture theories discussed below present post-formal methodologies as stemming from the algorithm. The first is the work of Kostas Terzidis who identifies the algorithm as operating post-axiomatic mathematics, an architectural-technical position framed in a book entitled *Algorithmic Architecture* (2006). As such, it is the first theoretical work to define the new architectural process as standing between two digital modes: a finite process, on the one hand, and an algorithmic process that realizes the potential to compute. The second theory deals with the post-formal implication on architectural theory and methodology, that of Mario Carpo (2011), who addresses the shift as a break from architectural history arguing for a departure from projectional, notational architectural processes.

The algorithm therefore is the meeting point of the mathematical and the computational, novelty is situated in the mathematical procedure that runs the software and operates generative processes, technically unattainable by the human mind. This is therefore a site of promise to the actualization of post-humanist practice. However, with the algorithm I show that not only the post-formal aspirations that underpinned *folding* and the *non-standard* have not ceased to be articulated within humanist chains but, moreover, the shift to algorithmic design in architecture enable these still modern and humanist chains to take a silent and therefore hidden role in directing the 'new' architecture. The

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[79] Mario Carpo reminds us of the association of the financial bubble and the architectural blob as one of the reasons for the coming of age of architectural digitality methodology, where 'the burst of the former did nothing to improve the reputation of the latter'. See Mario Carpo, *The Alphabet and the Algorithm* (Cambridge MA: MIT Press, 2011), 124.

previous narratives of novelty can therefore be viewed as sediments in the production of this new narrative, accumulated and suppressed under the homogenizing effect of post-formal narratives. The algorithm stops short of exposing the long hybrid genealogy I have accounted for above.

Kostas Terzidis: the Algorithm Will Free Our Minds[80]
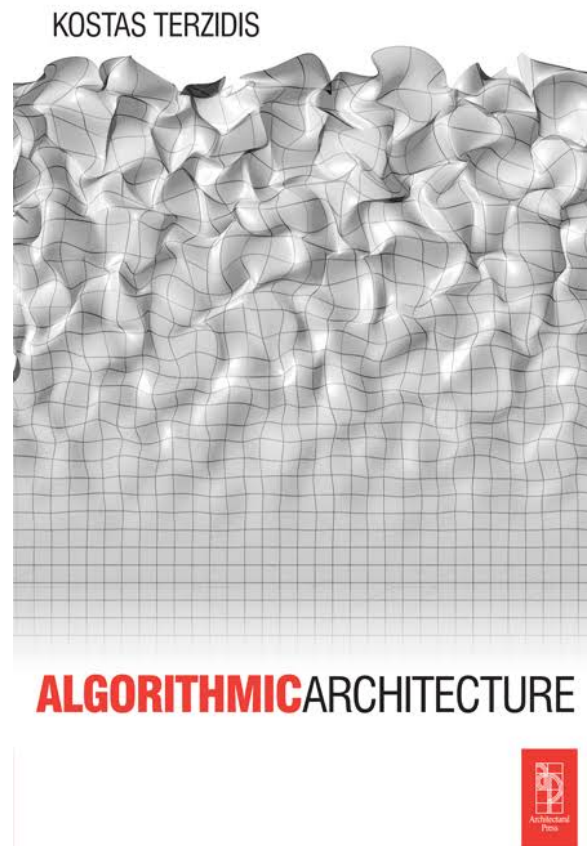
Figure 7: Kostas Terzidis, Algorithmic Architecture, 2006, book cover image

How does Terzidis define the algorithm in general and *algorithmic architecture* in particular? The algorithm is explained as 'a mathematical or logical mechanism for resolving practical problems. With the invention of computers, algorithms became frameworks for implementing problems to be carried out by computers' (Terzidis 2006, 16). The approach to resolving a problem when using algorithms varies from predetermined solutions, where the algorithm describes the steps to resolving problems, to a type of 'problems whose solution is

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[80] Terzidis is an Associate Professor of the Graduate School of Design at Harvard University. He describes himself as an educator, designer, theorist, architect and computer scientist. His professional work includes software development for Java media framework and Linux. He is also the author of *Algorithms for Visual Design, using the processing Language.*

unknown, vague or ill-defined' (ibid., 15). In an architectural context, the difference between these two modes of algorithmic production, explains Terzidis,

> involves the designation of software programs to generate space and form from the rule-based logic inherent in architectural programs, typologies, building code, and language itself. Instead of direct programming, the codification of design intention using scripting languages available in 3D packages (i.e. Maya Embedded Language (MEL), 3dMaxScript, and FormZ) can build consistency, structure, coherency, traceability, and intelligence into computerized 3D form. By using scripting languages designers can go beyond the mouse, transcending the factory-set limitations of current 3D software […] For architects, algorithmic design enables the role of the designer to shift from 'architecture programming' to 'programming architecture' (ibid., vii).

Terzidis's narrative frames novelty in the digital with the algorithm's potential to operate post-humanistic processes. The potential in 'algorithmic architecture' to operate alternative processes to formal ones does not, however, equate with the algorithm per se, but rather with the algorithmic application chosen by the architect. This is an important point to make because it places novelty not with the technical device, but with the content it is given and its implementation in a digital environment. Terzidis's account differentiates between two distinct digital methodologies in architecture, *computerization* and *computation*:

> Computerization is about automation, mechanization, digitization, and conversion. Generally, it involves the digitization of entities or processes that are preconceived, predetermined, and well defined.
>
> Computation is about the exploration of indeterminate, vague, unclear, and often ill-defined processes, because of its exploratory nature, computation *aims at emulating or extending the human intellect* (ibid., xi, my emphasis).

Computerization therefore is a restrictive methodology that maintains human control over computational processes. Alternatively, *Computation* explores methods beyond human cognition that hold the promise to 'extend human intellect'. While the former type of algorithmic solution mimics human cognitive procedure, the latter type of solution equates with what is commonly known in architectural terminology as *generative* or *emergence* solutions. Terzidis clarifies

that the promise of a new conception of architecture resides in the latter definition, in *computation,* emphasizing his views in regard to the former and stating that 'mouse-based manipulations of 3D computer models are not necessarily acts of computation' (ibid.). Terzidis posits the potentiality for novelty with *computation* as an alternative to traditional approaches in architecture that are entirely human-centric;

> [It is a] common belief among architects and designers that the mental process of design is conceived, envisioned, and processed entirely in the human mind and that the computer is merely a tool for organization, productivity, or presentation (ibid., 21).

Therefore, the algorithm per se does not equal a complex, non-dualist process. The capacity of algorithmic procedures to emulate or extend human intellect results from the architect's ontological and methodological design approach to the role of the algorithm as part of a digital design process. By operating processes the results of which are either 'unknown' or 'unimaginable', architects 'escape from human understanding since both negate two of the last resorts of human intellect, that of knowledge and imagination', claims Terzidis, a claim that places open-ended algorithms on the side of post-humanism:

> because they extend beyond the sphere of human understanding. Concepts such as randomness, infinity, limit, infinitesimal, or even more elaborate concepts such as complexity, emergence, or recursion are incomprehensible by the human mind not because they are metaphysical, magical, or mysterious but rather because they depend on intellectual means that are external and foreign to the human mind (ibid., 55).

However, and in the same breath, Terzidis concludes: 'An algorithm is not about perception or interpretation but rather about exploration, codification, and extension of the human mind' (ibid., 27). I return to this oxymoron in the last part of this chapter. But, now suffice it to say that the potentiality to a post-humanistic realm of production has been shut again by Terzidis's insistence on subjecting the capabilities of the algorithm to the narrowest understanding of subjectivity, as a central, cognitive and rational perception, still within the boundaries of humanistic thinking.

On many occasions throughout his book, Terzidis calls for a transparent, controlled and knowledgeable digital architectural process and appeals for better control of the digital script and the avoidance of a 'black box' of pre-given software, claiming that 'the majority of architecture practices, despite their appearance, are still developing ideas *through their own human minds*' (ibid.,40, my emphasis). Terzidis clarifies that it is not only ignorance of the processes themselves but a deliberate avoidance of such concepts: 'In fact many designers are not interested in mathematics of a design composition but rather in the composition itself' (ibid., 41). While reminding us that 'An algorithm is not only a computer implementation, a series of lines of code in a programme, or a language, it is also a theoretical construct with deep philosophical, social, design, and artistic repercussions' (ibid., xiii), his plea stops short at the theoretical argument that addresses the philosophical, social design artistic conditions opened up by the use of algorithmic architecture is made in general terms only, without elaborating on what these post-human methodologies, as he terms the algorithm, can possibly mean for our society and what is the great advantage he sees these new tools serving, what such extension enabled by post-human algorithmic processes hold for architecture. That is to say, Terzidis does not ground these tools in architectural practice, in the philosophical, social and design terms he identifies as the contextual background. Failing to ask these questions, Terzidis also misplaces the agenda of the first decade of digital architecture, as he refers specifically to Eisenman and Lynn's 90s' experiments, claiming that these architects and others articulated curvilinearity and continuity while being motivated by formal concerns,

> with the formal manifestation of scientific theories using the computer as a medium of expression. Instead of using computational theories as the structural foundation, they employed humanistic philosophical theories of the 60's and 70's to explain the complexity of the form they produced (ibid., 55).

Although I object to this analysis on the grounds of Lynn and Eisenman's motivation, philosophical references or methodologies, I nevertheless introduce this example because of Terzidis' specific use of 'humanistic' as an adjective in this analysis, a term that is often repeated in the book as opposed to 'post-

humanistic' digital architectural practices that he equates with open-ended design process that is problem-operated generative, emerging processes (all of which define non-dualistic, post-representational practice). Terzidis's early realization of the algorithm as operating in a field that exceeds its technicality marks an important contribution to embedding the algorithm away from an abstract, disembedded neutral application that stems from off-the-shelf architectural software and questions the deeper construction of mathematical and computational knowledge. However, while I support the need to ground the mathematical and computational discourse, Terzidis's account subordinates the algorithmic process to the human intellect, still within humanist ontology, because it maintains modern hierarchies between the architect and the design, between the intellectual and material phases of a design process.[81]

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[81] See the introduction for a discussion of modernity in comparison with modernism in an architectural context. As argued in the introduction, in this thesis I take the stand that postmodernism in architecture operates within modern ontology as well as epistemology. Postmodernism in architecture is a movement reacting against *Modernism* in architecture, mainly going against the lack of expression and the standardization of the built environment, which focuses as an alternative on a revival of historic formal styles, despite their conflation into a new visual narrative. The process deployed cannot be seen to operate as *postmodernity*, for it does not undo the centrality of the architect and the centrality of a formal *standard* – in other words, the centrality of representation. Mario Carpo, to whom I refer later in this chapter, associates modernity with Alberti's treatises *On architecture* in the middle of the fifteenth century, codifying the centrality of the architect and the division of labour between the architect and the builder, as well as defining the main methodology that corresponds to this separation and to the architect as a focal point of creation through the introduction of projective architectural processes: plans, elevations, perspectives, etc. He claims this tradition stretched therefore from the Renaissance until the shift to digital architecture.

Mario Carpo: Projection-free Architecture
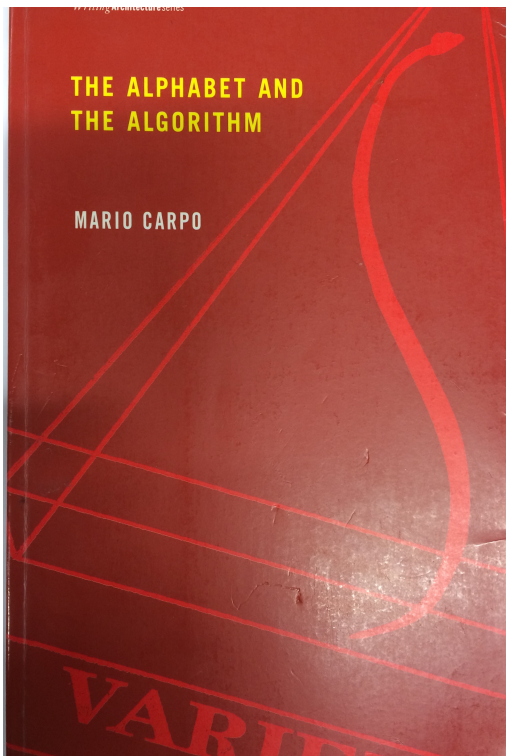
Figure 8: Mario Carpo, The Alphabet and the Algorithm, 2011, book cover image

In *The Alphabet and the Algorithm* (2011), Carpo departs from his 2004 narrative of *continuity,* which he attributed to the first generation of digital architecture, a narrative posited against the formal and programmatic fragmentation of postmodernism, and especially against deconstructivist architecture of the late 80s and early 90s. Carpo replaces this narrative with a new novelty narrative of *variability,* which he places within the algorithm. *Variability*, claims Carpo, overturns the premise of modernity as a project based on identicality:

> The modern power of the identical came to an end with the rise of digital technologies. All that is digital is variable, and digital variability goes counter to all the postulates of identicality that have informed the history of Western cultural technologies for the last five centuries. In architecture this means the end of notational limitations of industrial standardization, and more generally, of the Albertian and authorial way of building by design (Carpo 2011, x).

Carpo explains the shift to *variability* with the increasing availability of new digital tools to the architects of the late 90s enabled the computation, manipulation and production of complex forms. Carpo relates digital

architectural culture to pre-modern histories. By bridging pre-modern and digital architectures, Carpo brings to the fore a non-modern tradition that operates a different architectural thinking from the one we are trained to associate with modernity. Both pre-modern and digital methodologies operate away from the indexicality of the mechanical imprint, which was 'quintessential to the mechanical age' (ibid., 3). Rather, they operate in the realm of the variable – the artisanal variability of handmade production and the digital variability of the calculus-based functions. In both these cases, claims Carpo, 'visual identicality is quickly becoming irrelevant' (ibid.).

Modernity is equated with the identical, which defines the humanist-modern project in architecture:

> Since the rise of Renaissance humanism and the beginning of the Early modern Age, three instances of identical reproducibility have marked Western architectural history: the identical translation of design *notations* into physical buildings; the identical transmission of architectural *information* through space and time; and identical *fabrication,* or the pursuit of economies of scale through mass production and standardization (ibid., 81).

Throughout modernity, the architectural process was *projectional*: a design process defined by geometric linearity, a traceable straight line that leads from the architect to his design, manifested first in the graphic materials (plans, sections, elevations and perspectives) and projected on to the production of 3D architecture, which centred the identical, the standard formal reference.

The new digital age, claims Carpo, entails a shift in the design process because postmodern practices operate a different methodology, that of *variation*.

> But the shift from the mechanical to algorithmic reproduction also prefigures a parallel and equally crucial shift in our visual environment at large. We are leaving behind a universe of forms determined by exactly repeatable, visible imprints and moving toward a new visual environment dominated by exactly transmissible but invisible algorithms (ibid., 100–1).

And, therefore, his conclusion is that 'In the new world of algorithmic, or differential**,** reproducibility, visual sameness is replaced by similarity' (ibid.).

Carpo positions Alberti's invention of notational methods in the production of architecture compiled in *On Architecture,* 1452 as the watershed point between pre-modern (medieval) and modern architecture,[82] which he identifies as the beginning of a humanistic turn in architectural history, placing the architect as the author above and in separation from the architectural process:[83]

> Designers first need drawings and models to explore, nurture, and develop the idea of the building that, as Alberti states at the outset of his treatise, is 'conceived in the mind, made up of lines and angles, and perfected in the learned intellect and imagination' (ibid., 21).

Carpo describes the shift away from this modern world and its standardized form to the new digital era as a stylistic decision, stemming from the availability of these new forms to architects in the early 90s, as he recalls:

> almost overnight, a whole new universe of forms opened up to digital designers. Objects that, prior to the introduction of digital technologies, would have been exceedingly difficult to represent geometrically […] could now be easily designed and machine-made using computers (ibid., 36).

The trigger for this shift, explains Carpo, is the encounter with Leibniz's calculus. This aspect of the narrative is a repeat of his 2004 one; however, in *The Alphabet and the Algorithm* the appeal of Leibniz is explained not as driven by a quest for *continuity* in architecture, but rather as triggered by the computational ease of realizing Leibniz's mathematical models as complex forms.[84] Carpo acknowledges Deleuze's role in inspiring interest in Leibniz's mathematical concepts, but does not explain the reason for this infatuation. 'Differential calculus deals more easily with continuous lines and points of inflection than with gaps and angels' (ibid., 40), explains Carpo. Furthermore, the digital relies on mathematical formulae to generate formal variations, namely, on *non-standard series:*

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[82] See Carpo, *The Alphabet and the Algorithm*, 2011, 50–79. In this second chapter, *The Rise,* Carpo elaborates on Alberti's revolutionary treatise and its impact on the codification of architecture as a profession.

[83] Ibid., 20.

[84] Ibid., 39–40.

> A nonstandard series is defined not by its relation to the visual form of any constituent item, but by the variances, or differentials between all sequential items in the series […] in technical terms, all objects in a nonstandard series share some algorithms […] in visual terms, a nonstandard series comprises a theoretically unlimited number of objects that can all be different but must also be similar, as the digital tools that were used to make them leave detectable trace in all end products (ibid., 99).

Carpo discusses the connection between the algorithm and a non-standard series in the creation of variability in the following way:

> Algorithm, software, hardware, and digital manufacturing tools are the *new standards* that determine not only the general aspect of all objects in a nonstandard series, but also the aspects of each individual product, which may change randomly or by design (ibid., original emphasis).

Carpo's addresses the epistemic shift in ontological terms and discusses the changes to the authorial model of modern architecture towards a communal way of making architecture, with a rise of concepts such as 'agency', 'interactivity', and 'participation' as part of the digital discourse. A tendency that came to prominence, claims Carpo, especially after the *dot com crash* of 2000/2001, and in parallel with changes in the computational environment, described as a departure from the 'controlled, proprietary networked environment' of the 90s 'to a fully symmetrical, bidirectional informational framework' (ibid., 113). replacing the mostly mono-directional ('one-to-many') information technologies of the 90s.

> Some with vast social implications – and indeed, some of this software is also called 'collaborative' or even 'social' software […] in line with the general trend, the emphasis in architectural design has shifted from earlier, tectonically oriented applications to the interactive, 'horizontal' integration of the design process itself – and of the various categories of actors, agents, and agencies it may include (ibid.).

Carpo deals with these changes mainly from a legal point of departure, although he recognizes the difference between current-day collaborative models and past precedence, with 'traditional, consensus-seeking modes of "design by committee"' (ibid., 114) because of the open-ended nature of digital interaction in the current modes. However, in the epilogue to the book, Carpo revisits the

notion of agency as yet another empty neoliberal ploy: 'the same communal spirit that pervaded the Web 2.0 – in its multifarious, libertarian, as well as neoliberal manifestations – is now in doubt, and possibly retrenching' (ibid., 124).

Another important point Carpo makes is in relation to the new post-authorship culture emerging in digital practices:

> Open-endedness, variability, instructiveness, and participation are the technological quintessence of the digital age. They are here to stay. And soon designers will have to choose. They may design objects, and then be digital interactors. Or they may design objectiles, and then be *digital authors.* The latter choice is more arduous by far, but its rewards are greater (ibid., 126, my emphasis).

Carpo describes a surge in redefinitions of authorship in digital architecture arising in academic and popular platforms towards the end of the 2000s, recalling the appearance of terms such as 'agency', 'interactivity', and 'participation'.[85] However, Carpo points to a bias: 'technical interaction between networked machines attracted more interest than digitally enhanced social collaboration between humans' (ibid., 123). Carpo explains this tendency through the nature of the architectural profession, which has always been inclusive of many agents and therefore collaborative. Carpo rightly revisits this notion of agency as yet another empty neoliberal ploy: 'the very same communal spirit that pervaded the Web 2.0 – in its multifarious, libertarian, as well as neoliberal manifestations – is now in doubt, and possibly retrenching' (ibid., 124).

Gaps in the Narratives: Humanist Ontologies

Both Terzidis and Carpo relate the novelty in the algorithm to render the new architectural processes as post-humanistic. Terzidis' account traces infinite processes with the introduction of generative digital algorithms that operate

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[85] Around the same time that Carpo is referring to projects with a participatory nature there appears, for example: Spuybroek's *D-Tower* (2001–03), dECOi Architects, Hypo*surface*, first prototype 1999–2000. Both projects were exhibited at the *Architecture non-standard* exhibition 2003–04.

away from the known, the finite, the legible human-centric architectural process. Carpo relates this mathematics as part of a broader architectural thinking and declares the new methodologies to be operating away from the modern identical paradigm. A paradigm of variability identifies the new architecture, which Carpo relates back to pre-modern architectural practices. In the coming discussion, I show how these post-humanist tendencies of the new digital are discussed and appreciated within modernist ontologies, both highlight a similar absence, that of articulating the post-human as questioning the boundaries of the human as a subject.

Terzidis acknowledges the potential for novelty in the digital architectural process practised in the realm of *computation*, because this methodology operates complex processes, which are open-ended, where the answers are not predetermined, unimaginable and unknown, therefore, post-humanistic practices. However, these methodologies are then being reclaimed and attributed back to form an extension of *human* intellect. This subjection brings us back to a human-centric worldview; from this standpoint, the digital process is an extension of human intellect, as a means of amplification and, as such, it remains within the same humanist order, and not a means of breaking free from this limitation of cognition. Therefore, it can be said that, despite the author's distinction between the two alternative computer epistemologies, it is from an ontological point of view that we remain within humanistic, positivist boundaries aligning science with progress. The second point is the universalized aspect of such a narrative, which does not situate human intellect imagined in the questions: 'whose human intellect?' and 'towards what end?' This lack brings universalist and overarching arguments back into a discussion that furthers us away from hope for difference and variation.

Carpo's theory strength is in describing the premise of the modern architectural process and the common characteristics shared by the pre- and postmodern architectural world. However, I dispute his findings on three questions: on the question of what led to the shift, on the question of what it is the new methodology consists of and on the question of what these changes entail in practice. When it comes to discuss the reason for the shift to non-modern

practice in architecture, Carpo's account manifests the shortcoming of his humanist and modern ontology which confuses, as did his 2004 narrative, on the emergence of the tools as the cause for the ontological shift, which leads him to stress the turn to the variable as a consequence of widespread availability of new computational techniques. Carpo understands variability in the same way that he understood continuity, as a product, an outcome and not as a process. This is despite of the fact that when accounting for the shift from the pre-modern to the modern world, Carpo detaches modern tendencies in architecture from the industrial revolution to suggest that, in the case of modernity, the ontological shift preceded the epistemological one.[86] Carpo, however, does not linger on the significance of this stand, neither in relation to modernism nor to digital practices. As is the case with Carpo's 2004 narrative, this 2011 analysis misrepresents the motivation of the architects involved in *Folding in Architecture*. As in the 2004 essay, Carpo refers to a cyclical swing of formal sensitivities from the angular to the curvilinear as a matter of historical evolution.[87]

This reversed causality leads Carpo to reduce Deleuze's philosophy of difference, and to equate Deleuze's interest in Leibniz and *The Fold* as a result of a formal expression:

> Deleuze always referred to the fold in visual, geometrical terms (as the point of inflection that separates concavity and convexity in a curved line, or the point where a tangent intersects a curve), not in the abstract terms of modern differential calculus (where the point of inflection is defined as the maximum or the minimum in the first derivative of the function of the curve) (Carpo 2011, 86).

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[86] Carpo argues against theories that equate the transition from the pre-modern variable to the identical with the rise of photography and of cinema and rather relates it back to the invention of print and of geometrical perspective in the Renaissance. The history of architecture conflates both revolutions, its material tradition being linked to the industrial revolution, while Carpo traces architectural design back to Alberti. Carpo, however, does not account for the separation between the design and realization phases, between the intellectual and the material begun with the shift to the humanistic models codified by Alberti in the fifteenth century. This is to say that the humanistic ontology maintained this duality, regardless of the production-technological evolutionary stage. This instrumental historicity is carried over to Carpo's account of modernism as a predominantly machinic tale, see Carpo, *The Alphabet and the* Algorithm, 11–14.

[87] See ibid., 83.

Deleuze refers to the fold not only as a maximum and minimum point of inflection, but also as a metaphysical notion. I develop this argument further in cartography 2, part 1.

I argue for the opposite causality, as I show in the previous narratives, time and again and at various historical points, that the interest in subverting human-led architecture drives architects' experiments towards what is now known as the digital paradigm.

Secondly, Carpo's account collapses the mathematical and the computational realms and equates the algorithmic with non-standard seriality as the site of novelty in digital practice. This misrepresentation of the algorithm as well as of mathematics leads him to conclude that the new culture of *variability* stems from Deleuze's calculus. This aspect of the theory is inaccurate on two levels: as discussed in the previous narrative; non-standard seriality was not developed by Leibniz and is questioned by Deleuze. Moreover, although some algorithmic architecture is based on non-standard analysis (fractal, Voronoi amongst others), it overlooks other algorithms that are founded on other premises, such as genetic algorithms, multi-agent-based algorithms and more, all of which generate architecture of variation unrelated to non-standard series. I expand of those in the following section.

Thirdly, Carpo argues that the age of variability ends the grand and epic era of intent and control as a design methodology and collapses the rule of the original to denote authorship. In an environment operating away from a visual standard, explains Carpo, the architect cannot claim authorship over his creation because the projectional line, the linearity between intent and realization, is no longer traceable. This is more so with the post-2002 shift to serial mass production, which relies on an open-ended design process, shared between many entities. Nevertheless, these far-reaching changes are being discussed in humanistic criteria. Carpo traces a new path of architectural non-projectional processes, the overall reflection on the impact of these new post-humanistic methodologies is within humanist perception of subjectivity, those of authorship and intellectual rights, which attest to a centred and cognition-bound subject position.

The 2000–2002 *dot com crash*, asserts Carpo, restrained the digital formal exuberance of the turn of the century and directed the new architecture 'towards technical and social implications of a fully integrated design and production chain' (ibid., 41). This refers to the interest emerging in the 'capacity to mass produce series of nonidentical items' (ibid.). Despite Carpo's acknowledgement of digital architecture as operating methodologies outside the realm of 'western cultural technologies', he maintains humanist, modern, Western-limited parameters of discussing the implications of this revolution. That is to say, the criteria for evaluating the far-reaching effects of the shift to non-modern methodologies in architecture have not left the modern premises. Carpo accounts for the shift epistemically but not ontologically. Not only does algorithmic architecture imply a loss of culture of projectionality, but a second violation of authorial architecture takes place post-2002 – the introduction of a communal, open, horizontal aspect to design. The two impaired human control over the design process, due to the seriality of the processes as well as an open-source culture. However, the question of agency, with its potential to redefine not only the agency of architectural production but also the question of agency per se, remains within modernist ontology – for example, framing the shift in terms of its implication on intellectual property, which is still within a modernist discourse.

In Philadelphia in 2007, the architect Marc Fornes curated an exhibition featuring 20 digital practices, entitled *Scriptedbypurpose*; common to all these practices was a digital process that involved scripting. [88],[89] A second criterion for taking part in the exhibition was a disclosure of the design process alongside each project displayed:

[88] Marc Fornes is an American architect and founder of the practice THEVERYMANY https://theverymany.com (last accessed August 2016). He holds teaching posts in Princeton, and previously in Harvard GSD, Columbia University, and the University of Southern California.

[89] Invited: 4-pli, AKT, ARANDA/LASCH, Axel Kilian, BIOTHING, C.E.B. Reas, Christan Troche, coLab, DAG, DORA / Peter Macapia, EZCT, Ezio Blasetti / Vito Acconci, f-u-r, KOKKUGIA, Kyle Steinfeld, Marius Watz, Matsys, MESNE, minusArchitecturestudio, MOS, Neil C. Katz, Pigram/Maxwell, Proxy, SJET, SOFTlab, Stylianos Dritsas, THEVERYMANY. Using different computational languages (AutoLisp, Rhinoscripting, MEL, Maxscript, Processing, ActionScript, Java, etc…) compiled towards varying interests and outputs (digital art, design tools, form finding, optimization, problem solving, digital fabrication, etc…) https://scriptedbypurpose.wordpress.com (last accessed 5 August 2016).

> 1. All entries displayed should involve scripting techniques 2. In order to avoid a previous generation ruled by generic talks on 'techniques', all codes and custom tools must be displayed next to the work as open source – set up like some sort of a 'cellular automata' system, the show is based on those two rules only allowing a maximum of variation within the submission results to collect an 'emergent' spectrum of work within the field of scripting and design process ... within that dynamic process, a 'pattern recognition' step would than only be possible if a current form of model or classification would be available – are we there yet? (Scriptbypurpose 2007).

Philippe Morel, who provided the introduction to this exhibition, was quick to acknowledge the importance of the curator's request under the title of *Open Source,* referencing Negri and Hardt: 'that of a more radical and profound commonality than has ever been experienced in the history of capitalism', that of a 'productive world made up of communication and social networks, interactive services and common languages' (Morel 2007).

Mark Burry too referred to the same phenomenon:

> Liberating design force unleashed by the internet combining with the innate human desire to share knowledge; the *live hive* in which the collective critical mass is far greater than the sum of the individuals (Burry 2011, 10).

Carpo as well as the architects above assists in the lack of agential substance in the phenomena described by confusing the concepts of 'agency' with the notions of the 'collaborative' and 'participation'. These examples harness open-source to modern discursive frameworks, and fail to acknowledge the different ontological significance of *agency* to operate human interaction with others (human or not) beyond the prescribed and intentional concepts of human interaction assigned to collaboration and participation.

The Alphabet and the Algorithm fails to situate the shift in authorship in the digital tools themselves. While a large amount of detail is given to the *Alphabet* era as an architectural practice, the *algorithmic* era misses a technically specific layer of discussion: for example, one of the most important developments in this period, the release of the graphic algorithm software *Grasshopper* (2007), which is aimed specifically at architects, is missing from Carpo's account. Although

Carpo's interest lies in the transformation of the architectural design process, and this is where he sees his main contribution, the focus of the debate is still on the pre-digital history, on the modernist tradition preceding the digital. Consequently, Carpo elaborates on the moment of transition from a tradition of annotation, to a tradition of variability, while computation is treated as a black box, a meta-level of non-materiality, and at the same time a non-construction and an abstraction. As we saw in Terzidis' account of the algorithm, the algorithm itself is an empty tool that can take any script upon itself, non-standard or otherwise. Carpo's confusing the computational with the mathematical proves Terzidis' earlier concerns behind computation as a 'black box' and behind his appeal to architects to develop their mathematical skills, as a means to looking beyond the software and into the mathematical principles that operate them. The most interesting assertion he makes, however, in regard to the obsoleteness of visual criteria, an outcome of the shift to variable and non-projectional, is not developed as reconceptualizing the premise of subjectivity. The following discussion situates the digital and extracts it from its perceived neutral position.

From Post-humanist to Nomadic, Transposing Discursive Categories

I propose to turn the instrumental causality on its head – that is to say that the turn to post-formal/ post-representational/ post-axiomatic and post-human methodologies for the production of architecture is the driver for this turn, which coincided with the increasing availability of digital tools. This last part of the chapter is constructed in two parts, firstly it demonstrates how emphasizing novelty as driven by the turn to post-humanist explorations in architecture that are generative, materialist and in general post-formal and only later digital, expands the reach of the discourse to account for forgotten histories. Second it suggests an alternative understanding of this post-humanist turn that draws on nomadic theory and accounts for the new subject position. Such reconceptualization I argue opens up a path for novelty to be realized as difference. This investigation is further developed in chapter 3; here I continue

the cartographic process by grounding the discourse and by addressing its terms and definitions.

Post-humanist Architectures

My alternative reading of the history of digital architecture emphasizes framing novelty in digital architecture, not as a derivative of digital evolution but rather, as an outcome of a surge in the discontent with modern and modernist models in architecture to address the rising urban complexity, resources crisis and social instabilities of the 90s. I would like to stress my motivation for such a re-grouping – by shuffling distinct architectural branches I am not attempting to suggest a different historiography per se, but rather the creation of alternative genealogies that can better account for our historical moment, as well as, and this is my main motivation, to provide a new conceptualization of the subject of digital architecture that will allow me to readdress the state of the discourse especially in the coming of age of a non-critical paradigm associated with the digital.

The overall instrumental theorization of the digital, i.e. attributing the mechanism, or the tools as the main reason for the shift to digital architecture fails to account for an entire branch of digital production – a materialist one that assumes biodigital methodologies. The emergence of biodigital architecture cannot be explained by *folding* narrative, nor is it referencing Deleuze's topological systems, or any mathematical model for that matter, be it non-standard or another, and therefore cannot be explained by Migayrou nor by Carpo's narratives. Terzidis's understanding of the algorithm as an empty vessel comes the closest to account for the turn to biodigital architecture, but it is too focused on mathematical models, or the means by which these algorithms achieve an open-ended and complex qualities.

I refer here to complex scientific biological and computational models, which inspired an interest in emergent, material processes to architectural design, developing specific digital methodologies that are too post-formal. Framed in this manner, this phase of architectural experimentation in post-formal methodologies can be explained as part of a broader experiment that includes

other geographies and different methodologies, nevertheless contributing a similar trajectory. Such are experimental architectures practised at the Architectural Association (AA), London in the early 90s, which should be acknowledged in the pioneers' novelty narrative. I refer here specifically to two diploma units at the AA – that of John and Julia Frazer, diploma unit 11 and Michael Weinstock's diploma unit 4. John and Julia Frazer's work was exhibited at the AA already in 1995, an exhibition followed by the publication of the now seminal *An Evolutionary Architecture*. The work of Weinstock's diploma unit was presented at the AA in 1998, biomimetic experiments that had begun in the late 80s and have matured into *Emergent Technologies and Design* a current Graduate programme at the AA, founded in 2000.[90] Both these examples are not accounted for as part of the history of the first generation and remain outside of the American historiographic debate; equally, this branch is absent from Migayrou and Carpo's historiographies.

Both Frazer and Weinstock approach architectural design methodologies while directing materialist methods to the production of architecture, which we can refer to as morphogenetic. These methodologies stem from different plethora – a biological theory one and its codification in computation, such as genetic algorithms as well as other morphogenesis techniques. Like Deleuze's inspired methodologies of Eisenman, Lynn and Kipnis, and emerging at the same time, these methods defy the architect/ vision-centred modern methodologies and infuse them with post-formal, and therefore non-humanistic approaches. In other words, materialist methodologies, which locate the design processes away from the rule of vision and into the realm of dynamic materials able to form-find in detachment from a human mind. These are now established branches of digital architecture discourse.

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[90] See cartography 2, part 2 for a detailed discussion of their work.
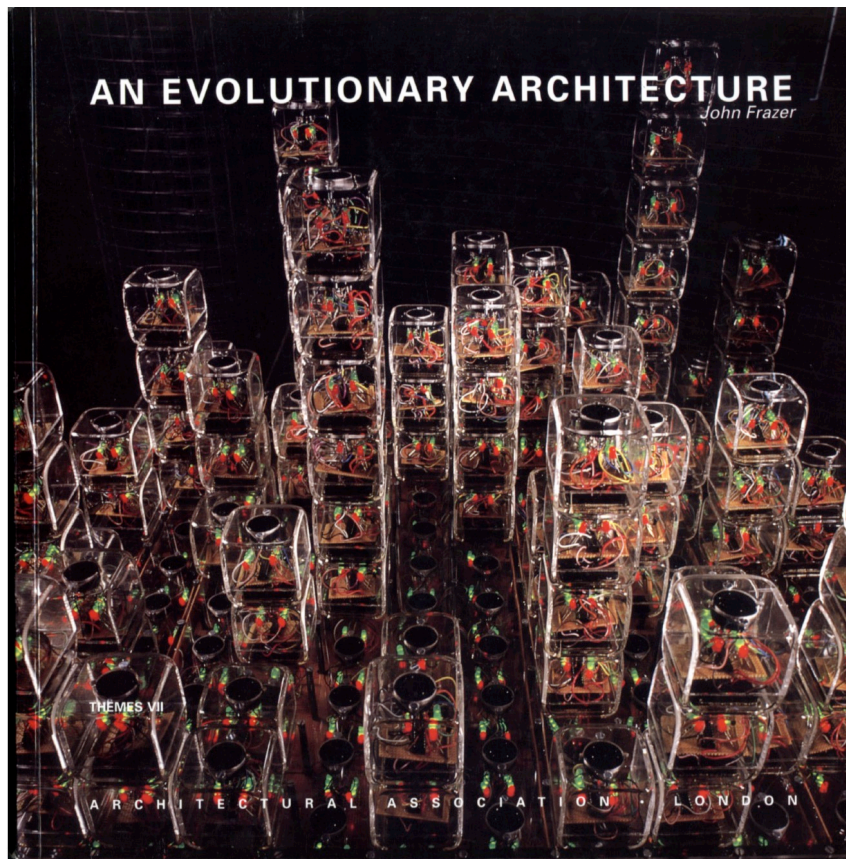
Figure 9: John Frazer, An Evolutionary Architecture, book cover image

In his book Frazer lays out the premise for a creative process in architecture:

> *An Evolutionary Architecture* investigates fundamental form-generating processes in architecture, paralleling a wider scientific search for a theory of morphogenesis in the natural world. It proposes the model of nature as the generating force for architectural form […] Architecture is considered as a form of artificial life, subject, like the natural world, to principles of morphogenesis, genetic coding, replication and selection. *The aim of an evolutionary architecture is to achieve in the built environment the symbiotic behaviour and metabolic balance that are characteristic of the natural environment* (Frazer 1995, 9, my emphasis).

This wealth of inspiration is positioned against traditional architecture, which 'has developed in the mind of the architect' (ibid.).[91] Such evolutionary methods do not follow projection, being based on the evolutionary model that 'operates without preknowledge of what is to come, that is without design' (ibid., 11). I

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[91] The exact mechanism and theoretical, biological and computational background that has enabled the development of this architectural approach is developed in Cartography 2, part 2.

expand on the origin of Frazer's biodigital methodology in the next chapter. At this stage, suffice it to say that Frazer developed a post-formal methodology emerging from the implementation of genetic algorithms that mimic evolutionary growth in his designs, which at the time was still predominantly pre-digital. Computation development can therefore by no means explain the turn to these methodologies in the first place; they can only explain their evolution.

Another example of materialist architecture is Lars Spuybroek's methodological approach, in place by the mid-90s with a clear agenda: to replace the role of representation in the architectural process. Detlef Mertins captures Spuybroek's novelty precisely in his defiance of the architectural projective dogma, while suggesting an alternative.

> His [Spuybroek's] response, in turn, has been radical and radically effective, for he sidesteps the issue of representation altogether to redefine the problem in other terms. In his hands, the computer has always been a *constructive* medium, not a representational one. It enables complex geometries that can also be enacted in other media or materials and at other scales, either before or after their life in the computer (Mertins 2008, 7, original emphasis).

Displacing representation was Spuybroek's main agenda in his early 1999 project – an exhibition entitled *Vision Machine*, held at the Musée des Beaux Arts, Nantes, France 1999–2000. That exhibition 'featured hundreds of mostly 20th-century artworks that examined the problem of vision: how it emerges, how it is structured and how it relates to body and space' (Spuybroek 2008, 95). Spuybroek's design addresses his critique of the insufficiency of the traditional division between plan and elevation to follow human perception. This division is replaced by a process of material form-finding, inspired by Frei Otto's *Bioconstructivism*, a technique of intuitive material form-finding, which follows a simple pre-digital technique using wool strings stretched at certain intervals on a disk and then immersed in water in order to come up with structural complexity that is initiated at the level of the materials, driven by deliberate forces of rotation.

Figure 10: Lars Spuybroek, Vision Machine, Exhibition space, 1999, France
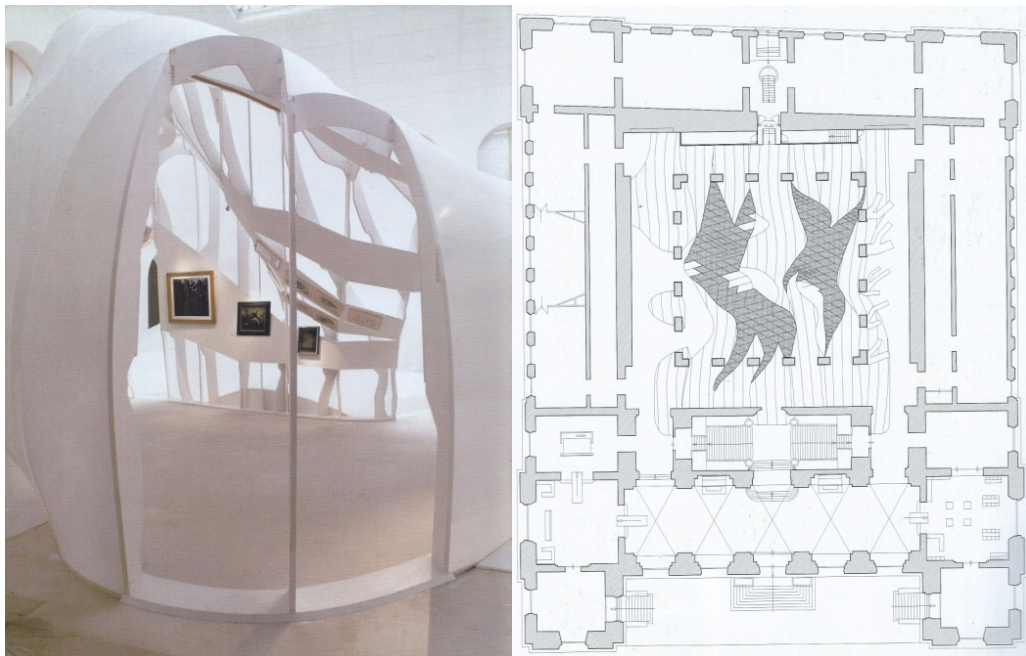
Figure 11: (left): Lars Spuybroek, Vision Machine, Exhibition floor plan, 1999, France

Figure 12: (right): Lars Spuybroek, Vision Machine, Internal exhibition space, 1999, France

The material is left to find its path at the end of the process, only then the algorithm being introduced to the system. In other words, Spuybroek uses morphogenetic processes, which suggests tying up the free agents (in this case, the diagrammatical strips indicated by the grid) to a deliberate movement, which he subscribes to a one-sided operation.

The examples above, now distinct, bodies of current digital culture began their architectural experiments based on post-formal design processes: materialist form-finding in the case of Lars Spuybroek and emergence morphogenetics in the case of John and Linda Frazer as well as Michael Weinstock at the AA, and cannot be explained by the above narrations of the turn to the digital.

Lars Spuybroek's later book *The Sympathy of Things*: *Ruskin and the Ecology of Design* (2011) addresses the turn to materialist approaches in architecture. Like Carpo's narrative, Spuybroek links the digital with pre-modern ontology claiming that these two architectural practices share similar methodology, though his emphasis is different. While Carpo concentrates on the variable (as well as the pre-modern) in epistemic terms, the pragmatic changes to the architectural production, Spuybroek frames the connection between the two eras methodologies in ontological terms. According to Spuybroek, the two eras share the ontology that triggers variation – a material, vital understanding of materiality. This is his non-modern narrative of novelty, the architectural outcome of which is far-reaching: such a vital, material approach replaces the humanistic separation between architect and builder, design and material with an entanglement of all dualities in the pursuit of architectural forming.

However, Spuybroek's narrative too is not free of humanist overarching qualities; his theory collapses material, emergence process back into an aesthetic realm, which centres on human vision. Spuybroek's tying the *vitalism* or *sympathetic relation* between the various parts as generated by a thrive for beauty is where the humanistic ontology takes over the new materialist. Such

relations land us back in a transcendental, universal project, a project of representation an ideal form of beauty.[92]
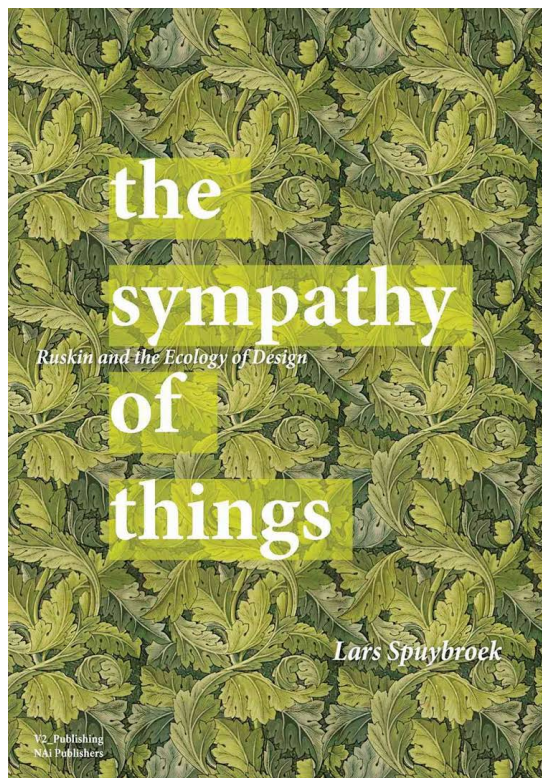
Figure 13: Lars Spuybroek, The Sympathy of Things: Ruskin and the Ecology of Design, 2011, book cover

Towards Non-representational, Nomadic Architectures

My cartography highlights a general undercurrent directing the distinct histories of digital architecture – according to which, these all seek to replace human-centric architectural conventions and processes with post-formal approaches to the production of architecture. These models, I have showed, have their roots in alternative architectural thinking of the 20th century, often as a counter current to architectural modernism, either through the use of topological models, or through the use of materialist models, both of which suggest a relationality between distinct materials and programs, not derived from a central decision point, and which does not rely on visual and cognitive faculties, (both models that are under scrutiny since the late 60s). Moreover, these new models challenge the centuries-old architectural divide between the conceptual and the

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[92] See Spuybroek, *The Sympathy of Things, Ruskin and the Ecology of Design*, (V2_NAi Publishers: 2011), 10, 275–7.

material and replace linearity with immanent models. In both cases of the topological and the material, as argued by Carpo and Spuybroek, there exists a pre-modern precedence. Referencing a pre-modern world in the context of architectural production is an important endeavour in decoding the modern architectural frameworks; however, what Carpo and Spuybroek as well as Migayrou and Terzidis fail to account for are the digital implications of these non-modern processes, in terms not only of the architectural object but of the architectural subject. That is to say that these regroupings with pre-modern traditions fail to propose real difference because the subject, although operating on a post-humanist digital platform, is still bound by overarching modern, humanist-oriented ontologies, producing a conception of subjectivity aligned with the 'image of thought' and therefore under perception that being is a unitary and monolithic one, coincided with language, reason and vision. These post-humanist systems may be vitalist but still arranged under the spell of *beauty* (Spuybroek), operate relational and non-linear processes, topological and other open-ended algorithms, but still bound to *rationality* (Migayrou, Frazer) as an extension of the human *mind* (Terzidis) non-projectional, but still bound to the central mastermind as a legal entity (Carpo). Being as one is the core of a dualist system that can only produce *otherness* but not novelty/ difference.

In this closing part of the cartography, I propose to transpose the discourse by suggesting it 'jump genes' to create old/new mutations between digital discourse and nomadic theory that (re)ties *folding* to Deleuze's non-dualist thought; the second, more specifically, ties the post-authoritarian to Braidotti's nonunitary as the first moves towards an articulation of digital subjectivity.

There was a brief moment in the history of digital architecture where the potentiality of post-humanist ontologies to articulate novelty as difference and therefore to address social and urban issues was embraced by architects, I refer here to the case of Eisenman, Lynn and Kipnis, but as I showed, paradoxically, in the absence of digital tools, these lacked epistemological rigour. In these examples, Deleuze's concepts of folding, as well as earlier concepts of nomadic

versus state architecture developed with Guattari in *A Thousand Plateaus,*[93] were drawn upon as new modes of engagement with the shifting modalities of capitalism (these were partially based on new mathematical models). However, the later narratives of this encounter, as I discuss above, stirred the discourse in a formal and mathematical direction while neglecting to acknowledge these post-formal approaches to architecture in their ontological relevance. As I argue, it is the failure to acknowledge these experimental attempts as rethinking of architectural ontologies, both by the architects practising these experiments and by the historians, that has resulted in the formal/ rationalist approaches that have found their way back into the discourse increasingly with the later development of architectural digital tool that berried ontological questions away from the surface of these operating tools.[94]

How can digital practice decode subjectivity reliance on modern concepts? In the next section I show how non-dualistic practice (Deleuze) and nomadic theory (Braidotti) can help us reconceptualize post-humanist epistemologies in digital architecture (i.e., non-formal, on all its methodologies: non-projectional/ calculated/ non-axiomatic/ autopoietic/ generative/ open-source/ agent-based), while reconceptualizing also the question of subjectivity.

The difficulty in untangling the convoluted state of the discourse, which conflates two distinct ontologies and many more epistemologies into an incoherent mass, is one of the main methodological challenges of cartographing the past 20 years attempts of theorizing digital architecture. It takes nomadic theory to undo all these conflicting genealogies, and it takes nomadic theory to propose a creative alternative. At this point I call upon nomadic theory and the restructuring of non-dualistic lines of flight, such as practised by Deleuze, as well as Braidotti's reconceptualization of non-dualist, materialist subjectivity along nomadic and nonunitary lines, that Braidotti calls for as a crucial stepping-stone in the articulation of real difference.

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[93] See Introduction, *non-dualist, embodied digital relations* and chapter 3 for the difference between the state machine and the nomad.

[94] I develop this point further in the next chapter.

I see much promise in a non-notational, non-projective, non-standardized architecture practised when understood in terms of the Deleuzian non-representational. In *Difference and Repetition*, Deleuze establishes the theoretical framework for the definition of a non-dualist, non-humanist differenc*e* and asserts that difference will cease to be a product of a binary structure, an opposite of sameness, so long as it is disassociated from representational humanistic processes of thought. Deleuze identifies four criteria to this disassociation: four 'iron collars' of representation – identity in the concept, opposition in the predicate, analogy in judgement, and resemblance in perception. Inspired by Foucault, who shows that these four dimensions coordinate and measure formal practice and define the classical world of representation,[95] later developed by Deleuze and Guattari in *A Thousand Plateaus* as the mechanism for the production of a hierarchy of sameness, the creation of a dominant apparatus of subjectivity, a mechanism placing the sovereign subject as the zero-degree of difference, Deleuze and Guattari coined as the 'majority subject' or the molar centre of being. In *The Fold* Deleuze gives us a spatial articulation of an alternative, non-dualist and non-representational system where he refers specifically to a spatial example, to Bernard Cache's *objectile* as that which already speaks the language of the non-representational, explained in terms of its new mathematical model, which describes variation rather than a form.

> This new object we can call *objectile.* As Bernard Cache demonstrated, this is a very modern conception of the technological object: it refers neither to the beginning of the industrial era nor to the idea of the standard that still upheld a semblance of essence and imposed a law of constancy [...], but to our current state of things, where fluctuation of the norm replaces the permanence of a law; where the object assumes a pace in a continuum by variation; where industrial automation or serial machineries replace stamped forms. The new status of the object no longer refers its condition to a spatial mold – in other words, to a relation of form-matter – but to a temporal modulation that implies as much the beginnings of a continuous variation of matter as a continuous development of form (Deleuze 2006 [1988], 20).

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[95] See Deleuze, *Difference and Repetition*, 174. See introduction for a detailed discussion.

This is therefore a meeting point between the epistemological to the ontological. From this standpoint, the variable, non-representational design process is an alternative to a dualist system of relationality. This alternative system is specifically addressed by a methodology – the differential calculus. However, I stress an understanding of the non-representational as a general critique of modern, human practices, which, as we saw above, originates as a reference to Western philosophy and not to a spatial model, and therefore should not be narrowed down to a formal understanding of *The Fold* – in fact, it should not be narrowed to *The Fold* per se. Aligning the non-formal with the non-representational entails basing architectural design on rigorous calculus-based or other process promoting relationality of derivation/ generation, defined by a reconceptualization of matter forming which is not subject to thought. This system does not value the conceptual over the material but allows for processes of relationality between dispersed components that are non-hierarchical and dynamic. However, this is not the extent of a non-representational system. It should be stressed that this profound change in the realm of the object entails changes to the perception of subjectivity, and Deleuze does not neglect this point, which follows immediately after. The non-dualist, non-representational system entails a new subjectivity that Deleuze terms *perspectivism,* as that which generates *point of view'*, which does not mean a dependence in respect to a pre-given or defined subject; to the contrary, a subject will be that which inhabits a point of view. Therefore, the transformation of the object refers to correlative transformation of the subject '[…] it is important to understand the transient aspect of this system', where 'every point of view is a point of view on variation. The point of view is not what varies with the subject, at least in the first instance; it is, to the contrary, the condition in which an eventual subject apprehends a variation' (ibid., 21). I discuss the convergence between the mathematical and the philosophical articulation of this concept in the next chapter, as such Leibniz's articulation of both the non-dualist (the mathematic) and the subjective (the philosophical). In the context of this cartography I stress the characteristic of this new subjectivity, it suffices to say here that the calculus-based process operates on the premise of derivation that relies on *affectual and imperceptible perception*, away from the rule of reason or vision. Another point on the

importance of such a process is that it does not articulate monolithic wholes, but rather shifting points of view, fractions, ad hoc individuations.

Not in relation to this specific spatial discussion, Braidotti in her early *Patterns of Dissonance* (1991), too emphasizes the role of a post-dialectic system put forward by Deleuze as an alternative mode of relationality,

> The goal of the process of liberation thus described is not to transform the powerless into the powerful or the slaves into the masters; it aims to surmount the dialectical system in order to arrive at a non-hegemonic form of consciousness (Braidotti 1991, 109).

In other words, 'the process of subversion that Deleuze advocates does not aim at a mere reversal of the balance of power, but rather at overcoming the dialectic of identity/ otherness which governess classical philosophical thought' (ibid.). The *other* is a structural necessity of a phallogocentric Western philosophy. However – and now I turn to a critique Braidotti expressed in this early work – although she has since modified her stance, it is still relevant to articulate it in this context because it illustrates the ease by which Deleuzian theory is being subsumed by current digital discourse. In *Patterns of Dissonance* (1991), she alludes to the fact that Deleuze's radical non-human world, and in his eagerness to undo phallogocentric Western tradition, Deleuze has emptied the socio-political empirical dimension of *others*, their bodies.[96]

As we saw in the above discussion, even in the cases where calculus-based architectural process was followed, as in the many examples suggested by Migayrou, Deleuze's non-dualistic system is indeed often seen as an opportunity to empty the architectural discussion of bodies and therefore of the socio-political dimension, creating a system that paradoxically fits into the status quo, rather than subverting it. I argue that this mutation of Deleuze's intention was enabled by a dual act, development in calculus-based mathematical applications that shifted the focus of the Leibnizian understanding of the infinitesimal aspect of the calculus, a discussion that forms part of the next chapter. Secondly, it is the

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[96] See Braidotti, *Patterns of Dissonance*, 119. See also in the Introduction to this thesis, under *Nomadic nonunitary subjectivity.*

very critique by feminist scholars and especially Braidotti that exposes the weakness of Deleuze's non-dualist system to such subsuming process.

Braidotti's work forms part of a wider new materialist strand,[97] increasingly prevalent as a reference point in digital architecture.[98] Braidotti adds to this discourse a reliance on a feminist political stand as a means to embed and embody materiality, with a non-fixed, yet situated, reconceptualization of subjectivity. That is to say that Braidotti's unique position is in holding on to Deleuze's non-dualistic and nomadic emphasis as a critique of human-centric Western philosophy while at the same time injecting subject position back into this system without annulling its non-dualistic premise. This is achieved by suggesting a concept of subjectivity that is embedded in historical, embodied location, yet at the same time nonunitary, and not one, affective and immanent. This is an ethico-political stand accounting for qualitative difference. Nomadic thought is an expression of a nonunitary vision of the subject, explains Braidotti, 'defined by motion in a complex manner that is densely material. It invites us to rethink the structures and boundaries of the self by tackling the deeper conceptual roots of the issues of identity' (Braidotti 2011, 3). Braidotti's nomadic subjectivity should be understood in detachment from notions of individualism, or any ego-indexed or fixed understanding of selfhood nomadic theory responds to the:

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[97] See, *New Materialism: Interviews and Cartographies,* eds, Rick Dolphijn and Iris van der Tuin (Ann Arbor: Open Humanities Press, 2012), for a comprehensive comparative study of the various strands of thought adhering to new materialism's core concepts. The writers define new materialism as follows: '[…] new materialism is a cultural theory that does not privilege matter over meaning or culture over nature. It explores *a monist* perspective, devoid of the dualism that have dominated the humanities (and sciences) until today, by giving special attentions to matter, which has been so neglected by dualist thought. Cartesian dualism after all has favoured mind […]. New materialist cultural theory shifts (post-) modern cultural theory, and provides an immanent answer to transcendental humanism'. 85.

[98] For example, Graham Harman's *object-oriented philosophy* is becoming popular with digital architects. Harman was invited to give a lecture at the Bartlett, as part of the Bartlett International Lecture series in 2013, where he was introduced by the digital architect Alisa Andrasek, then a lab master at the MArch Architectural Design course at the Bartlett School of Architecture. He recently contributed a paper for Migayrou's book *Naturalizing Architecture,* which I refer to in chapter 3. In this context I would like to point to his philosophical stand, which is new materialist and immanent; however, he centres his philosophy away from process and in the realm of essence, which nevertheless cannot be reduced and is therefore anti-empirical. See Graham Harman, "Objects and Architecture", in *Naturalizing Architecture,* eds. Marie-Ange Brayer and Frédéric Migayrou (Orléans: HYX, 2013), 234–43.

deficit in the scale of representation that accompanies the structural transformations of subjectivity in the social, cultural, and political spheres of late postindustrial culture. *Accounting adequately for changes is a challenge that shakes up long established habits of thought. In order to produce grounded accounts and more subtle differentiation in the kind of different nomadic flows at work in our world, we need more conceptual creativity.* More ethical courage is also needed and deeper theoretical efforts to sustain the qualitative shift or perspective that may help us confront the complexities of our era (ibid., 9, my emphasis).[99]

Braidotti captures the poverty of existing conceptual frameworks to sustain the flow of shifts, without which we are in the grip of the old, modern trap of dualism once again. This aspect of her critique is particularly apt in the context of theorizing digital architecture over the past two and a half decades, where the immediate default position of architects and historians alike is to retreat to modern concepts. I have accounted for some of these reframings of post-humanistic methodologies with dualistic concepts such as form, intellect, universalism and authorship. Nomadic subjectivity, claims Braidotti, frames the concerns for the tangled state of the discourse and the difficulties to account for this ontological shift in an environment that used the same techniques of differentiation.

To Braidotti, it is the materialist aspect of Deleuze's philosophy, especially with his collaboration with Guattari that makes this reinjection of subject-position emphasis possible. In the next chapter I show that the nonunitary to some extent is already part of the non-dualist system Deleuze reconstructs by drawing on Leibniz in *The Fold*, which is immediately related to digital discourse. That is to say that the materialist and embodied have many points of reference in Deleuze's work, and it is here that I see Braidotti's main contribution with her insistence on grounding/ positioning/ locating techniques coming from feminist discourse as well as framing Deleuze's non-dualism as a critique on capitalism techniques of subsuming the critical as part of creating of sameness mechanism.

As I showed throughout the chapter, the new architecture repeatedly ties its post-formal; post-humanist methodologies back to modern overarching

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[99] See Introduction for a detailed discussion on *nomadic theory* in general and *nonunitary nomadic subjectivity*.

ontology. In this context it is important to bring Braidotti's assertion that the synergy between the human and its technological tools amounts not to improved human capabilities (this clarification is important in relation to Terzidis's position in particular), but to a change in the structure of contemporary subjectivity, which is characterized as nonunitary, hybrid and therefore impure, denaturalized through technological mediation, and hence becoming post-humanist.[100] Post-humanism is not an end in itself but an opportunity for transpositions that work under the unitary assumptions of humanist thinking, and may introduce a path for difference.

This cartography therefore preforms an act of location, locating the discourse and embedding it in its various genealogies, but not as static means of historical tale, but as the grounds out of which new reconceptualization can now emerge. The next chapter continuous this trajectory by operating a similar motion; towards embedding the discourse in the molecular digital level, that of the methods and process themselves. Locating is a nomadic act in this context, an act of transposition.

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[100] See for example Rosi Braidotti, *Transpositions* (Cambridge: Polity Press, 2006), 96. For a more detailed discussion on the concept on nonunitary subjectivity see the Introduction.

CHAPTER 2 –

CARTOGRAPHY (2) – DIGITAL PRACTICES AND METHODOLOGIES

This cartography continues to ground digital architectural discourse claims of novelty; in this occasion the grounding is of the methodologies and digital tools that enable digital production in architecture. While the first cartography is concerned with narratives, this cartography embeds and locates my claim to a nomadic and forgotten layer of the discourse in the digital tools themselves.

The previous cartography shows branching into two methods of post-formal production, a mathematical-topological-based branch and a generative, biologically influenced one. In this cartography, both these strands are analyzed for the depth of their operating systems. In both cases, my cartography emphasizes ontology, a non-dualist and post-human ontological sediments underpinning these methodologies, which are departed from as the discourse evolves into the specificity of a digital process in architecture. Nonetheless, these ontologies are not lost and can still be redirected to inform our current digital realm. That corresponds to the power of *transposition* to inject counter flows in these finite and humanist entrenched mechanisms.

Part 1 – Differentiating Points of View – Situating Topological Digital Practice

Introduction

In the previous chapter, I addressed the gap between the narratives and concepts of digital architecture in general terms, analyzing the hybrid heritage of the canon as standing on the verge of a post-humanist era while still deeply rooted in modernist frames of thought and practice. In this cartography, I approach the question of novelty from a different angle, the mathematical-philosophical underpinnings of the discourse. This investigation leads me to

articulate a forgotten mathematical lineage that follows a thread connecting current digital techniques and software in digital architecture back to Leibniz's differential calculus in the seventeenth century. At the same time, this investigation traces the disappearance of a central element in Leibniz's mathematics and philosophy – the *infinitesimal*, a powerful tool that serves as a material as well as a metaphysical extension.[101] The infinitesimal aspect of the differential calculus has a double genealogy – a mathematical one and a philosophical one, both developed by Leibniz alongside as part of his philosophy of monadology. I discuss the convergence between the mathematical and the philosophical articulation of this concept to current mathematics, a relevant genealogy, I argue, firstly as an attempt to recouple current digital epistemologies with non-human ontologies. In a second stage, this genealogy is important as means to explore a potential nomadic route in current digital practices, which ignites a process of digital differentiating taking place later in the thesis. The monad, or monadology per se is not the concern of this thesis, but rather to trace the playing of the infinitesimal calculus as a non-dialectic system of relationality with the potential to bypass representation and particularly to unveil an embodied nature of these processes, which is also the philosophical aspect of this theory developed by Leibniz. This cartography emphasizes this embodied aspect by which the infinitesimal operates in Leibniz's model that is not only subjective, but affective and relational, and therefore investigates how this Leibnizian emphasis on preindividuated subjectivity can be reconceptualized as nomadic.

This is to argue that mathematics has an ontological aspect, as pronounced by Deleuze's as early as *Difference and Repetition* and primarily in *The Fold*. I frame Deleuze's interest in Leibniz as part of his greater interest in alternative modes of thought to the rational, axiomatic, finite concepts of scientific convention, which in the broader sense is also aimed at replacing our humanist conception of thinking. The infinitesimal aspect of the differential calculus plays a key part in this alternative reconceptualization. Retrieving it by Deleuze's *the Fold* therefore

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[101] I frame the infinitesimal as a post-human extension – an extension of the otherwise finite and predetermined mathematical world into a possibility of becoming. It is important to bear in mind that Leibniz's original aim in defining the infinitesimal was to define infinitesimal thinking, as it is associated with the irreducibility of the concept of God.

should be seen in relation to his quest for articulating alternative modes of non-dualist, non-representational relating both in mathematical terms, but moreover, in ontological term, as such I position its importance to my thesis, because its capacity to also articulate a nonunitary, embedded and embodied, nomadic reconceptualisation of subjectivity.

I follow this mathematical genealogy leading from Leibniz's infinitesimal calculus as it unfolds in Deleuze's writings, to current architectural digital software, *Grasshopper* (2007). I claim that the mathematical mutation that made its way to frame the topological-digital, that of non-standard based mathematics is the latest iteration in a systematic and deliberate omission of the ontological underpinnings of the differential calculus– namely, the infinitesimal aspect and their disappearance from the practicality of their quantitative functionality – this in turn leads to undifferentiated architecture. The differential's main promise for Deleuze – the assertion of difference as an alternative to the logic of the dialectic as the drive behind the creation of difference is marginalized, what prevails is a rationalist approach to digital architecture.[102] It is this disappearance of the infinitesimal calculus from mathematics, or rather its mutation, I argue that leads us to current practice axiomatics with its most extreme example – the appeal of software such as *Grasshopper* to current digital architects.

For a short moment in the history of the calculus, the ontological and epistemological aligned, on the threshold of the two centuries, the nineteenth and the twentieth, with Gauss and Riemann's mathematical development of the calculus, followed by Poincaré's which have allowed for the inclusion of the infinitesimal back in the calculus in a way that supported a non-dualist ontology. Their mathematical contribution, however, transposed the infinitesimal from the Baroque world of the monad to a new world of multiplicities, later to be

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[102] The claim that Deleuze's *The Fold* underwent reductive processes in its 'translation' to the domain of digital architecture is not new – the encounter between Deleuze's work and the architectural discourse is best captured in Frichot and Loo, *Deleuze and Architecture*, 2013, which I refer to in several occasions along the thesis. See for example the introduction, *Literature Review, Ethical digital discourse/ critique* and Introduction, structure*;* Cartography 1, *Introduction* and *Carpo's formal narrative* sections. In this cartography I situate and contextualize this discursive blockage in the mathematical-philosophical make-up of differential calculus within *The Fold,* but not exclusively, as I examine Deleuze's stand on the infinitesimal in *Difference and Repetition* (1968)*, A Thousand Plateaus* ([2004] 1980) and in the Leibniz seminar series Deleuze gave at the Université de Vincennes Paris VIII (1980).

embraced by Deleuze in his articulation of the nomad. It is the contribution Leibniz's monadology holds to the later development of *nomadology* as well as to nomadic theory that this thesis emphasis.

Understood against this background, tracing the infinitesimal is relevant not only as a means of filling in knowledge gaps – as curing digital discourse of its amnesia – but also as furthering the argument I develop in cartography 1: namely, that the potential of a differentiated post-human culture, I locate in the turn to the digital, cannot be realized while turning a blind eye to the ontologies, the philosophical and metaphysical origin of current digital tools. Leibniz's differential calculus should not be confused with the formality *folding* assumes, because calculus should not be seen as an enabler of novel forms, but rather as enabling a non-dialectic process of relationality. Misplacing this philosophy of difference is a result of a limited understanding of the mathematical and philosophical heritage of the differential calculus. The ontological, philosophical and, indeed, metaphysical aspects behind Leibniz's appeal to Deleuze's philosophy of difference in general, and specifically behind its articulation in *The Fold*, are overlooked in the literature of architectural history and theory, hence the epistemological-ontological gap I pointed to in the previous chapter. In other words, reclaiming the mathematical discourse as part of a greater ontology of difference production overturns the equation of novelty in digital architecture with the algorithm, a narrative, which I showed in the previous chapter to be insufficient to produce a theory of novelty.[103] This cartography therefore situates the discourse and is a first step towards a transpositional practice to investigate how we can reintroduce the infinitesimal as an extension to the mathematical model, as a move towards a post-humanist digital practice, which I undertake in the last chapter.

This cartography is constructed around the following questions:

1. What is the infinitesimal aspect of the calculus? What does the infinitesimal help Deleuze to achieve?

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[103] See Cartography 1, Narrative 2.

2. What is the process of mathematical differentiation? Why is this the epitome of non-essentialist, non-dialectic and non-representational process? What are the philosophical implications of the differential? What is being differentiated?

3. What is the importance of Gauss Riemann and Poincaré's multiplicity in realizing nomadology?

4. What does the disappearance of the infinitesimal from modern mathematics entail in terms of the articulation of novelty in digital architecture?

5. What does the transformation argued by Deleuze – that from monadology to nomadology – entail in terms of the infinitesimal calculus? If the monad is no longer feasible, what does it mean in terms of the mechanism that enabled it? What does it entail for the possibility of individuation?

This cartography highlights an affective and relational *embodied* aspect of the infinitesimal processes of differentiation, originating in Leibniz, an aspect, which is dwelled upon by Deleuze in his 1980 Leibniz's seminars, but it is nevertheless less prominent in the later *The Fold* discussion.[104] This embodied aspect of the calculus forms an important part of the transposition towards a nomadic digital alternative. Cartographing this embodied aspect is especially important on the backdrop of Braidotti's and others questioning the capacity of Deleuze's non-dualist system to incorporate embodiment that is located, and as such, social and political.[105] I maintain that this critique is based on embodied concept developed by Deleuze and Guattari in *A Thousand Plateaus*, which do not emphasize the notion of the singular on a variation that Deleuze develops in *The Fold*, and that it overlooks the insistence on a 'point of view' that is affectual and, therefore, by definition embodied. Can this articulation of subjectivity be transposed as nomadic? This is the main question this cartography aims to answer, as I weave together these two concepts of the nomadic, Deleuze and Braidotti's.

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[104] The Fold was originally published in French in 1988.
[105] This critique is voice by Braidotti in *Patterns of Dissonance,* where she specifically discusses two modes of embodiment developed in the work of Deleuze and Guattari, both taken form *A Thousand Plateaus,* the one is the body without organs and the other is. See Braidotti, *Patterns of Dissonance,* 108–23. See also this thesis' Introduction *Nomadic nonunitary subjectivity.*

Braidotti's contribution to this thesis in not only thematic, in framing nomadic subjectivity, but rather, subjectivity can assume figurations as part of a process of transpositions, transposing the humanist and unitary perception of subjectivity to an affective, embodied and embedded realm, which, according to Braidotti is an 'ethical' and 'sustainable' position.[106] *Transposition* is seen as a methodology that injects a discourse with the possibility of reimagining an ethico-political route. I join Braidotti in her effort to 'transpose nomadically from philosophical theory to ethical practice', an insistence she attributes to her feminist 'politics of location' (Braidotti 2006, 4).

In the previous cartography I showed that a post-humanist subjectivity is already a site of renewed reconceptualization within digital discourse that cannot be separated from the redefinition of the new object, and that post-humanist thought is already prevalent in architectural and digital circles, albeit its articulation within the humanist ontological boundaries of a unified and fixed conception of the subject. In this cartography I go on to argue that these old-new concepts of digital subjectivity are already linked to a post-humanist ontology, embedded in the mathematics of digital architecture, introduced by Leibniz, this motion is part of a process of transpositions that traverses the entire thesis.

Transpositions as a methodology is defined by Braidotti against the background of inspiration from genetics as well as from the world of music. This is to suggest a methodology that is impure 'intertextual, cross boundary or transversal transfer, in the sense of a leap from one code, field or axis into another, not merely in the quantitative mode of plural multiplications, but rather in the qualitative sense of complex multiplications'. Braidotti emphasizes that 'it is not just a matter of weaving together different strands, variation on a theme (textual or musical) but rather of playing the positivity of difference as a specific theme of its own'. In music, Braidotti explains, transpositions indicates 'variations and shifts of scale in a discontinuous but harmonious pattern', 'an in between space of zigzagging and crossing: non-linear but not chaotic; nomadic, yet accountable and committed – it is coherent without falling into instrumental rationality' (Braidotti 2006, 5). When discussing the genetic genealogy of transpositions,

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[106] See Introduction, under *Transpositions.*

Braidotti acknowledges two aspects of the process of genetic mutation, a non-linearity, 'jumping genes' as well as an embodied grounding aspect – genetic mutation is proved to be not predefined, but rather it is 'internally determined by the elements of the cell itself, and thus not prewritten in the gene'.[107] The non-linear aspect arises from 'mobility and cross-referencing between disciplines and discursive levels' (ibid., 7).[108] Transpositions therefore replaces linear methodologies with affirmative, multi-angled approach highlighting qualitative variations. 'Revisiting the same idea or project or location from different angles is therefore not merely a quantitative multiplication of options, but rather a qualitative leap of perspective' this entails a shift from 'system driven by classification' to 'a process-oriented method'. The key methodological feature that emerges from this is 'an intensive form of interdisciplinarity, transversality, and boundary crossing among a range of discourses' (Braidotti 2011, 225).

If in the previous chapter, the qualities of transposition as a methodology, emerging from music and genetics where metaphorical, assuming discursive jumps from one code to another in order to emphasis narrational mutations (such is the hybrid humanist/ post-humanist state of the discourse), in this cartography the musical reference is more apt for the subject matter, that of mathematics. Moreover, in this cartography, variation and derivation and the transversal of scales compose the mathematical methodology itself. This is an example of the politics of subsumption I addressed in the previous chapter. In *A Thousand Plateaus,* Deleuze and Guattari describe a movement from majoritarian to the minoritarian sciences, according to which, the majoritarian assumes minoritarian knowledge, such processes describe the embrace of nomadic and materialist reconceptualization of matter becoming by the major sciences, that is able for linear and static thinking processes, operated by the power of the

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[107] See Braidotti, *Transpositions*, 5–7, where Braidotti unfolds a wealth of alternative genetic research and history, mostly conducted by women scientists, such as Evelyn Fox Keller and Barbara McClintock as well as Dona Haraway. Braidotti quotes Hillary Ross on the importance of their research: 'DNA, far from being the stable macho molecule of the 1962 Watson-Crick prize story, becomes a structure of complex dynamic equilibrium.' This genealogy is discussed in the Introduction, see *Methodologies*.

[108] See the Introduction for a comprehensive definition of Transpositions.

state.[109] Although it defies the totalization of two distinct systems of thought and proves the porosity of both, this state of the discourse cannot be simply identified as a state of flux. Up to this point in the thesis, I have referred to this hybridity in historical and mathematical terms, but I will now turn to Deleuze and Guattari's identification of this hybridity in political terms, by two definitions of space – the *smooth* and the *striated* – and the interaction between these two distinct systems, which they observe as a historical undercurrent. The various types of smooth and striated spaces, also interchanged for nomad space and sedentary space, are presented in *A Thousand Plateaus*, where this discussion occupies an entire chapter, '1440: The Smooth and the Striated'.[110]

> We are always, however, brought back to a dissymmetrical necessity to cross from the smooth to the striated, and from the striated to the smooth. If it is true that itinerant geometry and the nomadic number of smooth spaces are a constant inspiration to royal science and striated space, conversely, the metrics of striated spaces *(metrori)* is indispensable for the translation of the strange data of a smooth multiplicity. Translating is not a simple act: it is not enough to substitute the space traversed for the movement; a series of rich and complex operations is necessary (Bergson was the first to make this point). Neither is translating a secondary act. It is an operation that undoubtedly consists in subjugating, overcoding, *metricizing* smooth space, in neutralizing it, but also in giving it a milieu of propagation, extension, refraction, renewal, and impulse without which it would perhaps die of its own accord: like a mask without which it could neither breathe nor find a general form of expression (Deleuze and Guattari 2004 [1980], 486).

The smooth is subsumed by the striated – it can now be said that not only the state of the discourse has convoluted humanist and post-humanist thought, but moreover, the differential is striated – while nevertheless maintaining a façade of the smooth, which is helped by the fact that, from an architectural standpoint, the façade is literally smooth.[111] Deleuze and Guattari give us an example which

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[109] For example, *A Thousand Plateaus,* 535: 'Minor science is continually enriching major science, communicating its intuitions to it, its way of proceeding, its intricacy, its sense of and taste of matter, singularity, variation, intuitionist geometry and the numbering number.'

[110] See, Deleuze and Guattari, *A Thousand Plateaus,* 474–500.

[111] The striated versus the smooth is a concept that occupies digital architectural thought as it lends itself to a general socio-political critique of parametricism practices. See for example, Douglas Spencer, "Smooth Operators: Architectural Deleuzism in Societies of Control" (PhD Dissertation, Westminster University, 2012).

is a specific reference to such a process that is important to the discussion to follow,

> The delicacy and complexity of the means by which Riemannian patches of smooth space receive a Euclidean conjunction (the role of the parallelism of vectors in striating the infinitesimal). The mode of connection proper to patches of Riemannian space ('accumulation') is not to be confused with the Euclidean conjunction of Riemann space ('parallelism'). Yet the two are linked and give each other impetus (ibid.).[112]

In their historical and political address of such processes, Deleuze and Guattari's historical references are nevertheless not recent. Braidotti as well as Brian Massumi, describe similar movement, nevertheless their argument goes further to assert that, in our neoliberal age, capitalism has mutated to assume not only the content of nomadic thought, but rather the codes themselves. That is to say that it assumes nomadic methodologies and tools in the production of neoliberal values, hence the ever present need to overcome this challenges in accounting for these mutations.[113]

The importance of transposition in operating a multi-angled approach, which is nevertheless grounded, therefore is all the more necessary – approaching the question of novelty from a mathematical and digital perspective, which is the scope of this cartography – yields a 'qualitative leap of perspective' that of perspectivism itself. As such, jumping codes recognizes other mutations suggesting a hidden layer of embodiment.

To this end, this chapter begins with a history of the differential calculus, reclaiming it from its insufficient treatment in digital scholarly and popular material and its relocation back as part of its long history of mathematical and philosophical production. I re-establish the connections between digital tools with Deleuze's alternative mathematical lineage which, in addition to Leibniz himself (1646–1716), includes his contemporary mathematicians and philosophers who shared his interests, as well as the disciples who developed his

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[112] I further discuss the socio-political implication of this stratification to digital discourse ability to ethically differentiate its practice in chapter 3.

[113] See Introduction, under *subsuming digital practices,* and chapter 3 in this thesis, where I elaborate on these claims.

theories – Maimon (1753–1800), Wronski (1778–1853) and Bordas-Demoulin (1798–1859). These, 'minoritarian' figures in the mathematical and philosophical lineage, developed the seeds of the branch of differential philosophy; I refer to here as *infinitesimal.* Another lineage established by Deleuze is a nineteenth- and twentieth-century mathematical lineage: Deleuze's mathematical genealogy proves the continuity between Leibniz's seventeenth-century mathematical notion of infinitesimal differential calculus through to the following mathematicians: Weierstrass (1815–1897), Gauss (1777–1855), Riemann (1826–1866), through to Poincaré (1854–1912) and Robinson (1918–1974), that take us up to contemporary topology, cellular automata, fractal theory and more – all of which form part of current digital tools and thought. My aim, however, is to bridge the historiographical gap between the history of infinitesimal calculus further beyond Deleuze and to discuss its relevance to the present day and in the context of the deployment of these mathematical concepts in a digital architectural context, especially in light of the proliferation of digital, or algorithmic, techniques in the production of current architecture and its reliance on these mathematical models.

This leads us to the second part, where I investigate the traditions of calculus that have informed the emergence of current mathematics – namely, topology and later, and finally the coding of these mathematics into the digital world in general, in parametrics and specifically in *Grasshopper*, the Rhino plug-in, a popular software within digital architectural circles. *Grasshopper* is widely used in mainstream, commercial digital production.[114]

The closing part addresses the altered notion of the material world of computational models of data, where I propose Leibniz's infinitesimal 'operation system'-*point of view/ perspectivism* as the articulation of embedding and embodying data, as a mechanism to introduce a concept of subjectivity, albeit a nonunitary one, to the digital. This last section picks up the thread of transposition that I introduced in the first chapter, while adding to the general notions of a non-dialectic digital, which I framed by the alternative concrete techniques of non-representational and nonunitary architecture.

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[114] By the likes of ARUP, Fosters and Zaha Hadid architects, to name a few.

The literature available to the architectural student/ scholar on the topic of digital architecture's mathematical underpinnings (Legendre 2011; Picon 2011; DeLanda 2002) stresses the continuity between calculus and present-day topology in current literature and tends to frame a rationalist, positivist mathematical tradition, stripped of any ontological baggage that can associate this mathematics with an alternative theory of relating. This disassociation allows for these, by definition, complex tools to be replanted into the *image of thought.*[115] This analysis becomes especially potent later in the cartography in relation to the example of Deleuze's mathematical work becoming accessible to the architecture audience with Manuel DeLanda's *Intensive Science and Virtual Philosophies* (2002).[116] A general and less mathematically informed paper coming from the history and theory of digital architecture is *Parametric Notations: The Birth of the Non-Standard* by Mario Carpo (2016), which attributes the birth of *parametricism* to the first chapter of Deleuze's *The Fold.*[117] Carpo misinterprets Deleuze's text by arguing that 'Deleuze was intrigued by the generality of the parametric notation' (Carpo 2016, 26). This is a misleading proposition that aligns with Patrik Schumacher's ambition of suggesting a totalizing and generic parametric style, known as parametricism.[118] These

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[115] I develop this notion of the 'image of thought' later in this cartography.

[116] Manuel DeLanda is established as one of the main mathematico-scientific references to Deleuze's work. He advocates an iteration of Deleuze's work that is stripped of its ontology. His book *Intensive Science and Virtual philosophy* is a reference book for Deleuzian mathematical concepts in digital architecture circles. See Manuel DeLanda, *Intensive Science and Virtual philosophy* (London: Continuum), 2002.

[117]*Parametric design/ Parametrics*, includes all digital architecture processes, which employ algorithms for generation of a design solution. Parametric design is therefore a broad term is used in interchange with 'digital design'. *Parametricism* was coined by Patrik Schumacher at the 2008 Venice Architecture Biennale, which refers to a new style of architecture that is based on parametric design but operate under specific premise which eschew rigidity (formal and functional). The main point iterated by Schumacher is that 'Parametricism implies that all architectural elements and compositions are parametrically malleable' See Patrik Schumacher, "The historical pertinence of parametricism and the prospect of a free market urban order", in *The Politics of Parametricism, Digital technologies in architecture,* eds. Matthew Poole et al. (London: Bloomsbury, 2015), 26. See also Patrik Schumacher, "Parametricism as style – Parametricist Manifesto", accessed January 2017. http://www.patrikschumacher.com/Texts/Parametricism%20as%20Style.htm. Schumacher published the theoretical premise to his claims in two volumes. See Patrik Schumacher, *The Autopoiesis of Architecture: A New Framework for Architecture* (Chichester: Wiley & sons, 2011). Vol. 2 concludes with a manifesto that calls for a new style of Parametricism.

[118] See Mario Carpo, "Parametric Notations, the Birth of the Non-Standard", in Patrik Schumacher (ed.) *Parametricism 2.0 (AD)* 86 (2016): 24–9. Carpo's paper is part of an AD guest-edited by Patrik Schumacher where he advocates these ambitions. The same views are presented in Schumacher's book see Patrik Schumacher, *The Autopoiesis of Architecture: A New Framework*

narratives of calculus cannot be further away from the complexity of Deleuze's calculus and from the philosophy that underlies it, as I show in this cartography. Another example of the rationalist and limited approach to the history of mathematics in relation to digital architecture is AD, *Mathematics of Space,* guest-edited by Legendre (2011). In the few cases where there is an attempt to reach back to the history of mathematics, these accounts are limited in scope and rigour, such another case is *The New Mathematics of Architecture* by Jane Burry and Mark Burry (2010).

For a relocation of the calculus in an alternative genealogy I turn to Deleuze's texts. Deleuze's interest in Leibniz's mathematico-philosophical concepts goes as far back as *Difference and Repetition* (1968) where he places Leibniz as part of an alternative philosophical lineage to the mainstream dialectic philosophical *image of thought.* He returns to Leibniz briefly in the *Logic of Sense* (1969) and then again in his work most associated with Leibniz and the Baroque – *The Fold* (1988) – where Deleuze's philosophy of difference is fully developed. In *A Thousand Plateaus* (1980), Deleuze and Guattari divert the discussion from calculus to the articulation of a mathematical smooth space through the work of Riemann's multiplicities. Deleuze dedicates a special place to Leibniz in his teaching at the Université de Vincennes Paris VIII, which is an invaluable source for the overall contribution of Leibniz's thought. [119] In my reading of Deleuze's mathematics I am aided by the philosophical-mathematical texts, again, external to architectural literature – namely, Simon Duffy's *Deleuze and the History of Mathematics: In Defence of the 'New'* (2013) and *Virtual Mathematics, the Logic of Difference* (2002), which together provide a rich and rigorous account of the mathematical sources that inhabit Deleuze's construction of a philosophy of

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for Architecture (Chichester: Wiley & sons, 2011, 4–14, 30–2, 54–70, where he discusses the applicability of parametricism to qualify as a 'Super theory' for architecture. Although, in an earlier publication (by Wiley again), that is not framed by parametricism per se, Carpo expresses a different sensibility to Deleuze's significance as promoting not only what he refers to as 'Leibniz's mathematics of continuity' but rather 'a whole post-modern universe of thinking that offered itself ... to the then nascent language of differentially: calculus describes variations [...]' see Mario Carpo, "Introduction to Twenty Years of Digital Design" in Mario Carpo (ed.) *The Digital Turn in Architecture 1992–2012* (Chichester: Wiley, 2013), 10.

[119] The transcript of an entire course dedicated to Leibniz's thought which took place in April and May 1980 have been translated into English. See http://www.webdeleuze.com/php/sommaire.html (last accessed October 2016).

difference. Deleuze's mathematical history as an under-researched field is acknowledged in the introduction to Duffy's book. His book is farmed with the function of mathematics in Deleuze's philosophy.

> Despite the significance of mathematics for the development of Deleuze's philosophy being widely acknowledged, relatively little research has been done in this area. One of the aims of this book is to address this critical deficit by providing a philosophical presentation of Deleuze's relation to mathematics, one that is adequate to his project of constructing a philosophy of difference, and to its application in other domains. This project undertakes an examination of the engagements between the discourse of philosophy and developments in the discipline of mathematics that structure Deleuze's philosophy (Duffy, 2013, 1).

Duffy's work exposes the mathematical underpinnings of the Deleuzian concepts, supplementing the structure of Leibniz's metaphysics, which underlie the entire text of *The Fold.* It is important to note that Duffy places the significance of *The Fold* in Deleuze's insistence on orienting the work around the metaphysical importance of Leibniz's mathematical speculation. I stress this point as an alternative to the available architectural literature above, from this standpoint Duffy's account being positioned as an alternative to Manuel DeLanda's texts, for example,[120] on the grounds that Duffy exposes the ontological question behind these mathematics.[121] A secondary source is Henry Somers-Hall's comparative account: *Hegel and Deleuze on the Metaphysical Interpretation of the Calculus* (2009), and Arkady Plotnitsky's *Algebras, Geometries and Topologies of the Fold: Deleuze, Derrida and Quasi-Mathematics Thinking (with Leibniz and Mallarmé)* (2003). Somers-Hall expresses a similar understanding of the role played by the infinitesimal calculus in Deleuze's ontology:

> Deleuze's aim will be to use the calculus to foster an understanding of the transcendental, free from all resemblance to the empirical, as it is only

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[120] I further develop this point in reference to DeLanda's reconstruction of Deleuze's mathematical references in cartography 2 of this chapter.

[121] It is important to note that Duffy views Deleuze's philosophy as metaphysical, and he dismisses attempts to portray his philosophy as a materialist ontology. Consequently, his approach to scholars in fields outside of philosophy working with Deleuze, such as the example he gives of DeLanda, is as follows: in order not to dismiss DeLanda altogether as an insufficient contributor to the work of Deleuze, Duffy establishes what I call a secondary order – a para-philosophical order that operates in parallel to the mainstream philosophical enquiry. See Duffy, *Deleuze and the History of Mathematics,* 168–9.

once this resemblance has been removed that the transcendental can be
seen as the grounds of the generation of the empirical, rather than simply
as a conditioning factor (Somers-Hall 2009, 567).

Somers-Hall's text targets the calculus as it is developed in *Difference and
Repetition* only.[122]

It is important to note that this cartography is not intended to be a
comprehensive study of the way calculus informs Deleuze's own genealogy, but
rather as a means to ground the digital discussion of both the calculus and
Deleuze back into the ontological context from which they were extracted. This
discussion is imperative as we move into the next phase of digital production
and the development of the digital canon by means of software and code that
relies directly on this mathematics. I begin this discussion by examining the
complex relationship between mathematics and philosophy in Deleuze's work,
but before I do so, I would like to briefly explore the current mathematical
discussion in the context of digital architecture.

Mathematics: Complexity in the Service of a Rationalist Ethos

The call to purify the architectural process by delving deeply into its
mathematical construction was uttered by George Legendre. Legendre, an
architect and theoretical thinker teaching at Harvard, was a guest editor of a
2011 Architectural Design, *The Mathematics of Space.* In his editorial, Legendre
claimed that the computational revolution has made mathematics a silent
partner to architecture, where the digital use of software renders transparent its
mathematical underlayer. Legendre summons his readers to expose this a priori
condition of mathematics in architecture, reconnecting the relationship between
spatial components and their numerical articulation:

> While our design culture has firmly embraced the innovations of
> computing, it has decidedly less time for the formulated thought lying at
> the very root of the breakthrough [...] The instrumentality of computation
> seems easier to grasp than that of mathematics, which good design

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[122] Duffy and Somers-Hall disagree on their overall analysis as to Deleuze's purpose in
the redeployment and reconstruction of the infinitesimal, but this does not undermine their
juxtaposition here for the purpose of their mathematical analysis.

software will render 'transparent' anyway. This transparency comes with a price. The underlying essence of formulated thought is often wrongly perceived to be no better than plumbing, and as much unworthy of being separated from the higher level functionality of design computing that has ultimately smothered it. As a result, in our software-saturated design environment the formulated syntax of mathematics is all too easily amalgamated with the functionality of digital tools, which mathematics enables – but also predates by thousands of years (Legendre 2011, 9–10).

Legendre's endeavour attempts to tease the mathematics out of computation: 'to reflect on the shared roots of our process, and the multiple ways these roots shape our practices and intellectual agendas while helping us define new directions' (ibid., 10). This engagement, however, is aimed specifically at enhancing control over the practice, as is made clear by Legendre:

> This issue would not be relevant without an applied survey of what mathematics can actually do for the practice. More than efficiency or technique, mathematics in design is ultimately about *individual authority* […] to work with commercial software is to work at the top of the pyramid, where the interaction is intuitive but the decisions have already been made. To write equations, on the other hand, is to work, if not at the bottom of the pyramid, at least pretty down low, where most of the room lies but little if anything is predefined […] To work with mathematics is to work with interface, and the difference matters, like any channel of communication, the interface conveys as much as it fashions the message itself, ultimately undermining the authority of the designer (ibid., 16–7, my emphasis).

At no point of his article does Legendre address his design agenda, and how this called-for sense of authorship is harnessed to the production of a better/different architecture. This consideration is given in hindsight, while evaluating the papers of others contributing to the publication: ARUP, Weinstock, Foster and Partners, Shigeru Ban and AKT, and his own practice IJP. The qualities gained by articulating the mathematics behind these projects are material considerations or spatial and organizational patterns, structural achievements by means of optimization – all from a technical and rational point of view, but what is the benefit of rejecting software as yet another consumer good? A practice so tangled up in mathematics has shed any consideration other than the production of elegant equations. Highlighting the importance of the numerical

attribute of any spatial component, as an ultimate means of control, is another example of how the reliance on mathematics (as a model of life) leads us not to a closer understanding of difference but further into the grip of controlled space.[123] In this context, a backlash against digital architecture is not surprising. Antoine Picon, in a paper published in the same AD mentioned above, guest-edited by Legendre, expresses a critique against architecture as a parametric space:

> the mathematical procedures architects have to deal with, from calculus to algorithms, are decidedly on the side of power. Nature has replaced God, emergence the traditional process of creation, but its power expressed in mathematical terms conveys the same exhilaration, the same risk of unchecked hubris as in prior times. What we want to recover is the possibility for mathematics to be also about restraint, about stepping aside in front of the power at work in the universe.

> It is interesting to note how the quest for restraint echoes some of our present concerns with sustainability (Picon 2011, 31).

However, it is clear from the following quotation that Picon is concerned with the very specific mathematics used in the past two decades of architectural production – namely, the reliance of architectural production on a mathematical model that does not operate a standard, and therefore distances the architectural creation from the human:

> In all these roles, mathematics had a strong link with spatial intuition. Arithmetic and geometry were in accordance with the understanding of space. This connivance was brought to the end with the development of calculus […] the calculus revealed the existence of a world that was definitely not following the rules of proportionality that architects had dwelled upon for centuries (ibid., 33).

Picon concludes by expressing the hope that mathematics will again guide architects in producing a standard or by enabling simulation – as a means to reconcile innovation with restraint. Picon is promoting a conservative understanding, as both his possible solutions mark a return to the known, to the actual, the controlled and the human. I propose a different approach – in which

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[123] See George Legendre, "IJP Explained: Parametric mathematics in practice", *AD Mathematics of space* 81, no.4 (2011): 44–53, for an overview on IJP, Legendre's own practice.

hubris is one attribute, an attribute of a humanist practice. However, restraint is the other side of the same coin, both being part of a dialectical system that operates sameness. Picon's call for the introduction of restraint into architectural practice is a de facto call for conservative architecture, architecture of a standard, as he reminisces about times when mathematics and geometry were sources of intuition for the architect. His is a call for an architecture of representation.

I would like to follow a different path, embracing the very mathematics that makes it impossible to apply a standard, yet not for the sake of hubris – but in order to follow an ethical route. As my argument goes contrary to that of Picon, it is not because of the introduction of non-standard mathematics to architecture that we are in the presence of hubris, but rather in conflating the non-standard with the all too human – and by that I mean rationalist overarching models of thought. With the introduction of algorithmic processes to architecture, there lies the potential to bypass this binary. For it is isolating mathematics from the production of extension in thought first and foremost that hinders us from fulfilling the potential rooted in this very mathematics for the creation of a post-representational practice; it is by removing the formal, rational and other humanist residue that we can remove architecture from hubris.

I argue that separating mathematics from the broader ontological questions is equivalent to caging complexity within a rationalist, modernist and humanistic context. What I refer to here is that a mathematical model, as complex as it can be in terms of the relations it creates between its components, operates in a vacuum despite the fact that the mathematical tools are surfaced and accurately and knowledgably used. In contrast with Legendre, I posit a methodology that questions the neutrality of mathematics and seeks the accountability of architects beyond mathematical proficiency; it is a call to immerse mathematics in nomadic ontology.

The Infinitesimal Aspect of Calculus

Deleuze and non-dualist mathematics
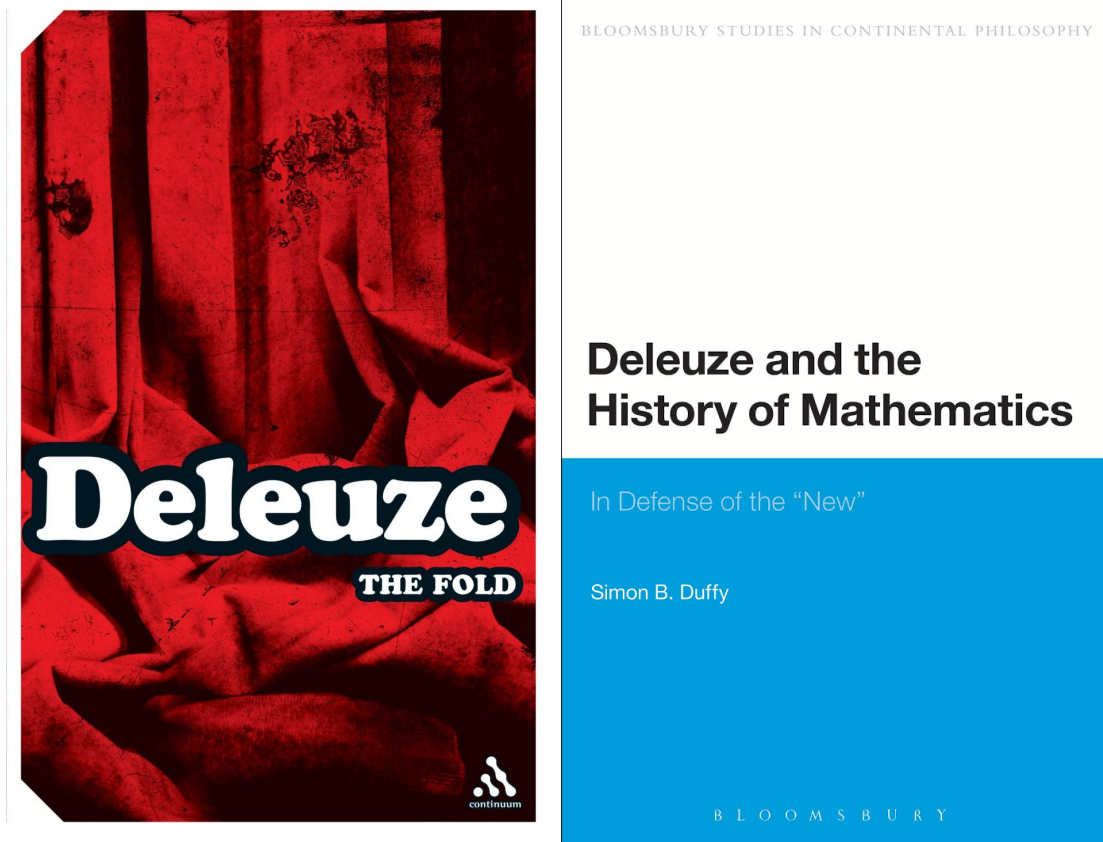
Figure 14 (left): Gilles Deleuze, The Fold, 1988, book cover image
Figure 15 (Right): Simon Duffy, Deleuze and the History of Mathematics, 2013, book cover image

The first question we need to ask ourselves is how does Deleuze understand the relationality between mathematics and philosophy? I divide Deleuze's approach into two strands. The first is mathematics as a concrete function, the second is mathematics as the canvas he draws upon in order to expose the nomadic (as an alternative to the royal sciences in this case), anti-axiomatic alternatives to otherwise finite and axiomatic sets of theories, and as such to the mainstream production of knowledge, a subversion to a field laden with the means of rebuking its own historiographies.[124],[125] This role of mathematics in Deleuze's

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[124] I elaborate on the difference between the two types science according to Deleuze and Guattari in chapter 3.

[125] Such an approach is put forward as an alternative to majoritarian philosophy. For example, in *The Critique of Pure Reason* Kant distinguishes between philosophy and mathematics as two distinct entities and, moreover, two spheres of knowledge that are obtained by two distinct methods: mathematics is perceived as a priori, universal and accessed by *pure intuition* of space and time. According to this view, mathematical knowledge is synthetic, a priori and

work is less important to my analysis. However, this reconstruction of minor traditions in mathematics serves another role in relation to his ontology. Deleuze gives us a window on to his own perception of the relationship between mathematics and philosophy in his Leibniz seminar, given in Vincennes, Paris, in 1980:

> if Leibniz is one of the great creators of differential calculus or of infinitesimal analysis, undoubtedly this is in mathematics, and he always distinguished philosophical truths and mathematical truths, and so it's not a question for us of mixing up everything. But it's impossible to think that, when he discovers a certain idea of infinite analysis in metaphysics, that there aren't certain echoes in relation to a certain type of calculus that he himself invented, notably the calculus of infinitesimal analysis (Deleuze, Vincennes Session, Leibniz Seminar 22 April 1980).

The complexity of this relationality is already evident, and is further complicated when Deleuze elaborates on the infinitesimal aspect of the differential analysis. It is here that he provides a twist that allows him to operate the infinitesimal as materialist reality, precisely because it is in the mathematical realm that the infinitesimal is a fiction, irreducible to the mathematical reality:[126]

> In all sorts of texts, people have always had me say that differential calculus designated a reality. I never said that, Leibniz answers, differential calculus is a well-founded convention. Leibniz relies enormously on differential calculus being only a symbolic system, and not sketching out a reality, but designating a way of treating reality. What is this well-founded convention? It's not in relation to reality that it's a convention, but in relation to mathematics. Differential calculus is symbolism, but in relation to mathematical reality, not at all in relation to real reality. It's in relation to mathematical reality that the system of differential calculus is a fiction. So, in my opinion, it does not mean at all that differential calculus does not designate anything real, it means that differential calculus is irreducible to mathematical reality. It's therefore a fiction in this sense, but precisely in so far as it's a fiction, it can cause us

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universal. Philosophy, on the other hand, is based on a posteriori concepts, is empirical and embedded in human experience. This stand in relation to the question of knowledge formation cannot be further away from Leibniz's dynamic analysis. See Duffy, *Deleuze and the History of Mathematics,* 47–52, for an elaborate account of Kant's concept of mathematics.

[126] At this stage, Deleuze refrains from mentioning Abraham Robinson and his nonstandard analysis, which turns on its head the above separation. Robinson's analysis vindicates the infinitesimal as a mathematical reality but not the metaphysical one. I develop this point later in this cartography.

to think of existence. In other words, differential calculus is a kind of union of mathematics and the existence, specifically it's the symbolic of the existent (ibid.).

Already at the very foundation of this discussion, we encounter the labyrinthine nature of differential calculus, which makes it impossible for it to be applied as an axiomatic framework, as it is the very relationality that is the propeller of the mathematical idea as much as it is the propeller of other, material relations. Deleuze draws upon various branches of mathematics: algebraic topology, functional analysis and differential geometry – mathematics that defies axiomatics in order to redeploy what Duffy describes as:

> the logic of the generation of mathematical problematics, i.e. the calculus problem, in relation to the history of philosophy, as a model for the generation of philosophical problematics. It is in relation to the history of philosophy that Deleuze then determines the logic of generation of philosophical problematics as the logic characteristics of a philosophy of difference (Duffy, 2013, 156).

The infinitesimal as a mathematical concept

It is important to clarify that Deleuze positions the differential calculus as means of relating quantities of different magnitude which are otherwise incomparable.[127] Differential calculus calculates the slope or the rate of change of the curve at a point calculated as a ratio of two sides of the right-angled triangle in order to find the angle that determines the rate of the change, or the angle of the tangent to the circle at this point. Leibniz thought of these relations as being 'infinitesimal' quantities.[128] It is in the fact that dx and dy have no meaning in themselves, nor in relation to a standard (a determined point), an x or a y, but rather the relationality between these two that makes this invention radical.

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[127] See Gilles Deleuze, Vincennes Session of April 15, 1980, Leibniz Seminar, http://www.webdeleuze.com/php/sommaire.html, accessed 30 October 2016.

[128] 'dx or dy is the infinitely small quantity assumed to be added or subtracted from x or from y. Now there is an invention! The infinitely small quantity… that is, it's the smallest variation of the quantity considered. It is unassignable by convention.' Explains Deleuze in a seminar dedicated to Leibniz. "Leibniz 22/04/1980", *Les Cours De Gilles Deleuze*, accessed 30 October 2016, http://www.webdeleuze.com/php/sommaire.html.

Leibniz invented the expression **dx** to indicate the difference of two
infinitely close values of **x, dy** to indicate the difference of two infinitely
close values of **y,** and **dy/dx** to indicate the ratio of these two values. This
notation was beautifully intuitive and is still the preferred notation for
thinking about calculus. Its logical basis at the time was questionable,
since it avoided the objections listed above by claiming that the two
quantities have not vanished at all but have yet become less than any
assigned positive number (Cooke 2005, 470).[129]

Another way of defining the differential calculus, which will help later with the
development in the field, is through its singular points, or singularities.
Singularities are the point on the curve where the shape of the curve changes
behaviour:[130]

a singularity is a distinct or determined point on a curve, it's a point in the
neighborhood of which the differential relation changes its sign, and the
singular point's characteristic is to extend [*prolonger*] itself into the whole
series of ordinary points that depend on it all the way to the
neighborhood of subsequent singularities. So I maintain that the theory of
singularities is inseparable from a theory or an activity of extension
(Deleuze, Vincennes Session, Leibniz Seminar 29 April 1980).
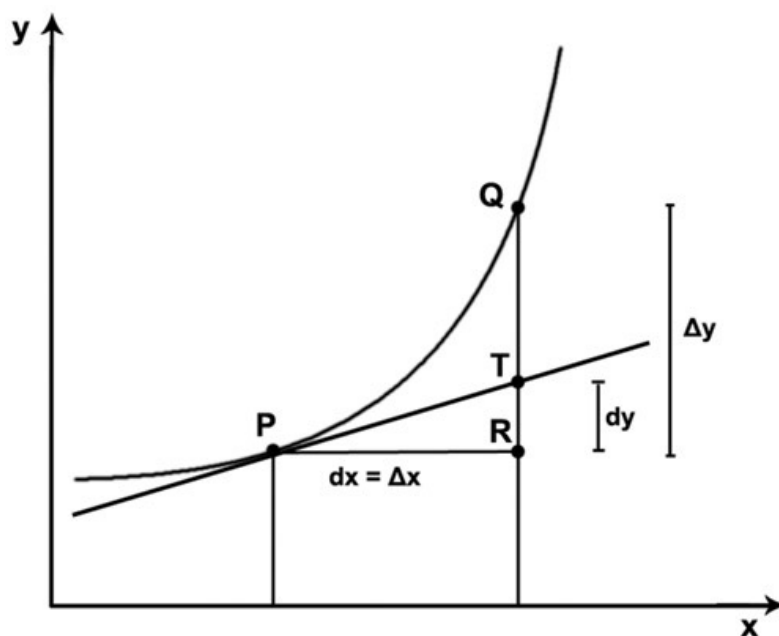
Figure 16: The differential relations dx/dy expressed as a tangent to a curve at p.

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[129] It is important to point to the fact that *The History of Mathematics,* a general history of
mathematics is a general history of mathematics reference book. by Roger Cook, a professor of
mathematics.

[130] For example, when the differential relation is equal to zero, the gradient of the
tangent at that point is horizontal, indicating that the curve peaks or dips, determining, therefore,
a maximum or minimum at that point.
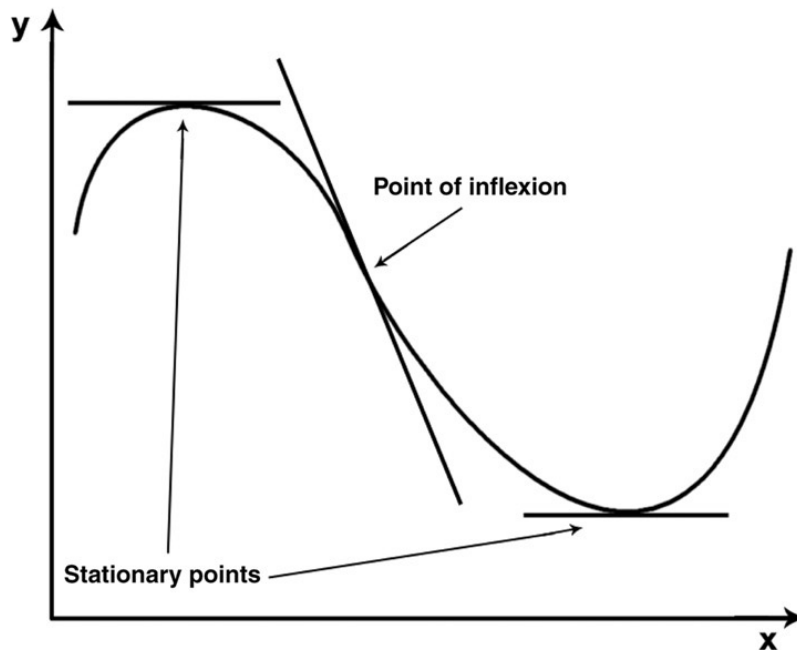
Figure 17: Stationary point = singularities

Singularity, explains Deleuze, is not positioned in relation to a universal but in relation to the regular, the differential relation characterizing not only the singular points which it determines but also the nature of the regular points in the immediate neighbourhood of these points – that is, the shape of the branches of the curve on either side of each singular point. This differentiation, in principle, can be maintained ad infinitum, with each value determined by differentiation then itself being differentiated, moving from the gradient of the singular point to second-order differential relation that produces the second derivative, indicating the rate at which the gradient is changing at that point. This allows for a more accurate approximation of the shape of the curve in the neighbourhood of that point.[131] Duffy explains that the value of the third-order differential relation 'indicates the rate at which the second-order differential relation is changing at that point'. Points of inflection 'mark a transition between

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[131] Simon Duffy further explains that 'Leibniz referred to the stationary points as maxima and minima depending on whether the curve was concaved up or down, respectively. A curve is concave up where the second-order differential relation is positive and concave down where the second-order differential relation is negative.' See Simon Duffy, *Deleuze and the History of Mathematics, in defence of the 'New'*, 16–17.

a region where the curve is concave up and one where it is concave down'. At which point, 'The second-order differential relation will be zero' (Duffy, 2013, 17),[132] and further on the significance of the point of inflection:

> The nth-order differential relation at the point of inflection would determine the continuity of the variable curvature in the immediate neighborhood of the inflection with the curve. Because the point of inflection is where the tangent crosses the curve [see figure 2] and the point where the nth-order differential relation as $n \to \infty$ is continuous with the curve, Deleuze characterizes the point of inflection as a *point-fold* (ibid., 16–7).

What is the significance of this mathematical invention to Deleuze's philosophy of difference is the topic of the next section.

The Infinitesimal as a philosophical concept as an alternative to representation

From the *Image of Thought* to subjectivity

In this section I discuss the appeal of differential calculus as an infinitesimal analysis to Deleuze as part of his greater philosophy of difference and specifically how differential calculus challenges dialectical thinking, and practices of representation in particular. I commence with a brief introduction to these concepts in Deleuze's work, as it unfolds in *Difference and Repetition* and in *The Fold* before I move on to consider Deleuze's seminars on Leibniz to gain a technical understanding of how the mathematics and the philosophy operate their own differentiation.

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[132] Duffy further explains: 'Deleuze distinguishes a point of inflection, as an intrinsic singularity, from the maxima and minima, as extrinsic singularities, on the grounds that the former ''does not refer to coordinates'' but rather ''corresponds'' to what Leibniz calls an ''ambiguous sign,'' that is, where concavity changes, the sign of the second-order differential relation changes from + to -, or vice versa.' Ibid.
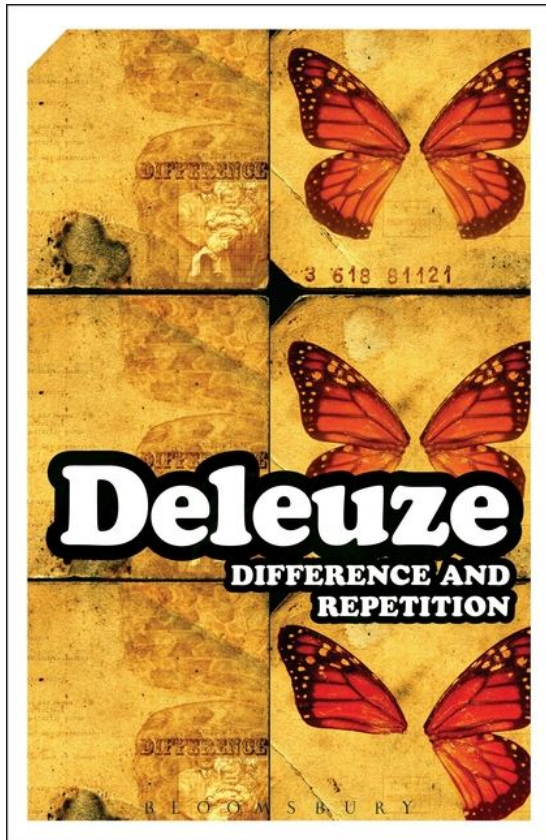
Figure 18: Gilles Deleuze, Difference and Repetition, book cover

Already in *Difference and Repetition* (1968), Deleuze develops an alternative mathematical genealogy under the umbrella of 'Ideas and Synthesis of Difference' (chapter 4)*.* It is important to note that this chapter follows on from a chapter entitled 'The Image of Thought', the diagnostic part of the book in relation to the persistence of repetition as representation etched in Western thought in general, but especially in philosophy. *Difference and* Repetition's 3rd chapter is therefore an open challenge to the Western equation of thought with the faculties of recognition.[133] In the fourth chapter of *Difference and Repetition*, Deleuze turns to Leibniz's development in mathematics in direct relation to an attainment of a non-dualist method of relationality seen as an alternative to *the image of thought* with the potential to bypass the rule of representation. In *The Fold*, Deleuze goes back to these first notions established in his early work, but here in the context of the critique of Western thought, relocating Leibniz's mathematical leaps in the period of their development and grounding Leibniz

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[133] See introduction *Difference*, where I go into further detail in establishing Deleuze's concept of newness as difference.

back in the Baroque, reuniting him with a forgotten lineage of thinkers. *The Fold* enhances the impossibility of undoing mathematics from philosophy and vice versa, a notion that was only theoretically pronounced in *Difference and Repetition*: 'tie the value of the symbol dx to the existence of infinitesimals; but it is also a mistake to refuse it any ontological or gnoseological value in the name of a refusal of the latter' (Deleuze 2004 [1968], 217).

The first assignment that Deleuze takes upon himself in order to shake off the rule of the four *iron collars of thought* is to undo the subordination of the predicate to its subject, as that which pulls the subject to represent the image of thought (doxa) either by means of identity, negation, resemblance or analogy (the essence of a dualistic system).[134] The Leibnizian differential relations are seen as a mechanism of relationality that does not originate from a determined value, x or y,[135] and which gives rise to its point of singularity as well as to its regular point (to a curve) by means of differentiation, but rather, as explained above, by means of a non-dialectical system that Deleuze mobilized to challenge the Western, humanist *image of thought.* This unfolding nature of differentiating, a variable mechanism that in the previous section described a curve, is in itself differentiated to theorize an alternative thought process:

> It is therefore differentiable in turn, *and testifies only to the power of ideas to give rise to Ideas of Ideas.* The universal in relation to quality must not, therefore, be confused with the individual values it takes in relation to another quality. In its universal function it expresses not simply that other quality but a pure element of qualitability. In this sense the Idea has the differential relation as its object: it then integrates variation, not as a variable determination of a supposedly constant relation ('variability') but, on the contrary, as a degree of variation of the relation itself ('variety') to which corresponds, for example, the qualified series of curves. If the idea eliminates variability, this is in favour of what must be called variety or multiplicity. The idea as concrete universal stands opposed to concepts of the understanding, and possesses a

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[134] See Deleuze, *Difference and Repetition*, 174.

[135] Henry Somers-Hall described it in the following way: 'The primitive function, which deals with the relations of actual magnitudes, is tied to representation, whereas the differential function, which specifies values in terms of *dy* and *dx* falls outside representation.' See Henry Somers-Hall, "Hegel and Deleuze on the metaphysical interpretation of the calculus", *Continental Philosophy Review* 42(2009): 569. Accessed 23 November, 2016. Doi:10.1007/s11007-009-9120-2.

comprehension all the more vast as its extension is great. This is what defines the universal synthesis of the Idea (Idea of the Idea, etc.): the reciprocal dependence of the degree of the relation, and ultimately the reciprocal dependence of the relations themselves (ibid., 219–220).

This is not the extent of Deleuze's ambition in regards to the function of differential calculus; it is not only a process of relationality in thought that Deleuze sees in Leibniz's differential, but rather an understanding of being in the world as derived from Leibniz's monadology,[136] not as a means to conceptualize the divine, but rather Deleuze is drawn to the process of individuation that it entails, and it is here that the main importance of singularities ripens to encompass the relations, the modes of perception and the vehicle of perception through which *subjectivity becomes, but never as a totality*.

> Leibniz tells us that consequently there really have to be unconscious perceptions that we don't perceive. These are called minute perceptions, that is, unconscious perception. Why is this necessary? [...] Leibniz gives us two reasons: it's that our a-perceptions, our conscious perceptions are always global. What we perceive is always a whole. What we grasp through conscious perception is relative totalities. And it is really necessary that parts exist since there is a whole. Henceforth, since we perceive the global noise of the sea when we are seated on the beach, we have to have minute perceptions of each wave, as he says in summary form [...] let me point out simply that in all of Leibniz's texts, there are always two distinct arguments that he is perpetually trying to make coexist: an argument based on causality and an argument based on parts (Deleuze, Vincennes Session, Leibniz Seminar 29 April 1980).

In the next paragraph, Deleuze, after Leibniz, explains the point of singularity as part not of a mathematical but of a metaphysical world, describing the movement in and out of perception that defines a moment of consciousness. I see in this mechanism an early description of nonunitary subjectivity. The importance of this mechanism to my thesis is in locating the mathematical with the ethical. The moment of singularity is the moment the sign changes (from + to

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[136] Simon Duffy defines *Monadology* as follows: 'The indivisible unities whose reality provides a metaphysical foundation for matter while residing outside of the indefinite progress of parts within parts are immaterial substances that Leibniz call *monads* [...] it is by means of the monad that the multiplicity of parts of matter that make up a body can be considered as a unity. The monad is prior to the multiplicity that constitutes the body, and the monad exists phenomenally only through the body it constitutes.' Duffy 2013, 39.

– and vice versa). This is also at the moment when a minute perception, which we cannot perceive, 'approaches or enters into the neighbourhood of a singular point, a remarkable point, that perception becomes conscious'. *A relationality between "physical elements and my [biological] body"', which are no longer relations of parts but of *derivation*. Furthermore,

> It is the differential relation between that which excites my body that is going to permit the definition of the singularity's neighborhood. So we pass from minute perceptions to unconscious perception via addition of something notable, that is, when the series of ordinaries reaches the neighborhood of the following singularity, such that psychic life, just like the mathematical curve, will be subject to a law, which is that of the composition of the continuous (ibid.).

To conclude, we move from the principles behind the system that furnish *Difference and Repetition* in relation to the *image of thought* as history of ideas, and on to an *investigation of how this system accounts for the relationality in our world, which is an embodied and embedded relationality*.

In *The Fold*, Deleuze proposes a political alternative to being in the world. The post-dialectic accents of *Difference and Repetition* have become an alternative ontology of human interaction. There are no boundaries between the arts in the Baroque; Deleuze refers to this quality as an extension.[137] That sense of overlapping and of porosity of one art to another, not confined to its frame/space, a sense of continuity, physical and conceptual, is highlighted in *The Fold*, enabled by differential calculus. This continuity is seen first and foremost as a reversal of social hierarchy towards immanence: '*The sum of the arts becomes the Socius, the public social space*' (Deleuze 2006 [1988], 142, my emphasis). Deleuze describes Leibniz's contribution to the Baroque as enabling the transformation of the isolated, perceptible object into a series of figures that are all subject to a law of continuity; nevertheless, the model according to which they still maintain their subjectivity returns us to *Difference and Repetition* and to Deleuze's earlier claims that, with the differential calculus, the determinable coexist with the indeterminable:

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[137] See Deleuze, *The Fold*, 141.

the assignation of events that correspond to these figured aspects, and that are inscribed in propositions; the prediction of these propositions to an individual subject that contains their concept, and is defined as an apex or a point of view, a principle of indiscernible assuring the interiority of the concept and the individual. Leibniz occasionally sums it up in the triad, 'scenographies–definitions–point of view'. *The most important consequence that ensues concerns the new relation of the one and the multiple* (ibid., 145, my emphasis).

Undetermined, Determinable, Determined: The Three Simultaneous Modes of the Differential

I return to the signification of this theory of individuation in terms of point of view and perception in the closing section of this cartography. Now I would like to return to the technicality of how Deleuze coincides the physical (mathematical) infinitesimal with the metaphysical (philosophical) infinitesimal. Deleuze resolves this by referring to a metaphysical aspect of the calculus that is not available within mathematics itself.[138] He draws on three theories of alternative figures in the history of philosophy and mathematics – Bordas-Demoulin, Maimon and Wronski, all marginal to the history of mathematics – to come up with a solution that defies the rationalist distinction between finite and infinite. The differential calculus is simultaneously *underdetermined* in the sense that the differential, *dx,* cannot be given through intuition, as it holds no meaning in terms of x,[139] *determinable* in the sense that it defines the complete range of values of the function, and *determined* in the sense of the specific value that the

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[138] See Henry Somers-Hall, *Deleuze's Difference and Repetition* (Edinburgh: Edinburgh University Press, 2013): 133–4.

[139] Somers-Hall elaborates on this point in an earlier publication, dedicated to the importance of the calculus to Deleuze: 'Deleuze argues that while dx is strictly nothing in relation to x, this is not because the differential is not in a sense real, but rather because it cannot be captured by either (Kantian) intuition or the categories of quantity. This characteristic of falling outside of both quantity and intuition is what Deleuze calls "continuousness," as he refers the reader to the original discussion in The Fold.' See Henry Somers-Hall, "Hegel and Deleuze on the metaphysical interoperation of the calculus", 568. It is important in this context to mention that Somers-Hall and Duffy are in disagreement on this point. Somers-Hall argues that Deleuze rejects Leibniz's infinitesimal and seeks to establish a third definition of the infinitesimal, one that does not fall in the domain of the finite nor the infinite. Duffy, on the other hand, distinguishes between the infinite in the mathematical and the infinitesimal in the philosophical domains. I side with Duffy on this one, as I have demonstrated with Deleuze's own words earlier. Nevertheless, I find Somers-Hall's explanation and references to the mathematical concepts that helped developed this concept with Deleuze valuable.

function can take at a specific moment. The curve, therefore, is a *generation process*. With the contribution of Wronski that the differential equation allows us to identify a specific value of x, Deleuze has developed the following system as an alternative to the Kantian dialectic and representational system: a determined value that is equivalent to the intuition, a determinable equation that subsumes it as the concept, and the field of differentials which challenge both the determinable and determination – the open-ended infinitesimals. In other words, as an alternative to the development of a problem in the Western philosophical tradition – the problem intrinsically subsumes the solution.[140]

For Deleuze, argues Somers-Hall in another publication dedicated to comparing Hegel and Deleuze's concept of the calculus (2009), the insistence on dx and dy as indeterminable, not bearing a quantitative value in relation to x/y, should not be understood on the premise of the differential as unreal, because it cannot rely either on Kantian intuition or on a category of quantity. *Falling outside both intuition and quantity is what Deleuze terms 'continuousness'.* Continuity here is explained as the transcendental condition of variability, the possibility of variability.[141] This point is important to the understanding of the significance mutation the differential calculus goes through in the centuries succeeding Leibniz.

The infinitesimal decline

Although it is Leibniz who introduced the term 'function' into mathematics, it is important to note the absence of a fully developed concept of function in the

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[140] For Bordas-Demoulin, *dx* does not represent a variable that can be given different particular values, but rather a radical break with understanding structure in actual terms and, therefore, the differential allows him to present a difference in kind between the Idea and its instantiations. Because despite the fact that *dx* and *dy* (the differentials) are undetermined in relation to representation, when they are put in relation to one another, they produce a determinable equation – the rates of change of a function at each point in time (for any value of x). Maimon, in turn, takes the differential to be the source of a construction of a phenomenal world. The differential gives us the rules that determine the infinite relations of the object, which the finite intellect is unable to process at once. Therefore, it cannot be an a priori or given aspect of the object but, rather, Maimon shows how intuition emerges through the finite intellect's inability to think the relations of differentials all at once, as a process of unfolding, or becoming. It is never a passive observation but rather a correspondence. See above for an expanded account, or refer back to the original text: Gilles Deleuze, *Difference and Repetition*, 217–18.

[141] See Henry Somers-Hall, "Hegel and Deleuze on the metaphysical interpretation of the calculus", *Continental Philosophy Review* 49 (2009): 568, accessed October 2016, doi 10.1007/s11007-009-9120-2.

Leibnizian context of algebraic relations between variables. For Leibniz, neither the equation nor the variables are functions in the modern sense; rather, the relation between x and y was considered to be one entity. To Leibniz, it is the curve that gave rise to the equation, and not vice versa – *the curve was not seen as a graph of a function but rather as 'a figure embodying the relation between x and y'* (Duffy 2013, 13, my emphasis). This is a significant emphasis; it posits the importance on the act of derivation as a process in emergence, rather than on a predetermined relationality with a known graphic outcome (a curve).

In the eighteenth century a shift occurs from the curve and the geometric quantities themselves to the formulae, which expresses the relations among these quantities, thanks in large to the symbols introduced by Leibniz himself. The focus of this mathematics was the analytical expressions involving numbers and letters rather than the geometric objects for which they stood. Duffy describes this shift as the moment in time when the differential underwent a change – according to which, *'it lost its infinitesimal geometric connotations and came to be treated as a concept connected with formulas rather than with figures'* (ibid., 14, my emphasis).[142] Therefore, 'the infinitesimal sequences are no longer induced by an infinitangular polygon standing for the curve [the relation between dx/dy] but was replaced by a function, defined as a set of ordered pairs of real numbers' (ibid.). The significance of this shift is that the metaphysics of the differential relations as an infinitesimal relation cannot be sustained by the turn to a functional representation.

The elimination of the infinitesimal from the calculus and its replacement with a static interpretation of the differential, using real numbers only, was consolidated at the end of the nineteenth century with the work of Weierstrass, which further drove the Leibnizian differential beyond the reach of the infinitesimal and in the order of axiomatics.

> Weierstrass […] creates an axiomatic of calculus, but at what price? He transformed it completely. Today, when we do differential calculus, there is no reference to the notions of infinity, of limit and of tendency toward

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[142] Duffy further explains that with the emergence of the concept of the function – the differential was replaced by the derivative, which is the expression of the differential relations in the function, first developed in the work of Euler (1707–1783). See Duffy, 14.

the limit. There is a static interpretation. *There is no longer any dynamism in differential calculus, but a static and ordinal interpretation of calculus* (Deleuze, Vincennes Session, Leibniz Seminar 29 April 1980, my emphasis).

For a while it seemed that the Newtonian calculus was vindicated.[143] The elimination not only of geometry but also of the Leibnizian infinitesimal was altogether completed. Developing arithmetical means to prove the calculus at the expense of geometry (because of its inaccuracy when it comes to limits) drove the infinitesimal to the margins.

The above-mentioned history of the profound changes in the ontology of the calculus is never mentioned in architectural context. That is to say that the calculus history is never told against the backdrop of the greater intellectual debate between Newtonian and Leibnizian heritage, which is a debate between finite and infinite approach to the calculus. Rather, the correspondence between Leibniz's mathematical inventions and topology is told either as an uninterrupted history, as an evolution of mathematical ideas, accordingly differential calculus led to the mathematical discoveries underlying current architectural digital tools (for example in Burry, 2010), or omitted altogether from the history of topology.

On the one occasion when a rigorous account of Deleuze's mathematical thinking crossed over to the architectural discourse, it is in a cloak of instrumentality. I refer here to Manuel DeLanda in his account of Deleuze's *Dynamical Processes* (DeLanda's terminology to describe Deleuze's non-dualist/ non-essentialist philosophy). DeLanda's historiography begins in the nineteenth century with a reference to the mathematicians Gauss and Riemann, and their work on *Manifolds.*[144] This departure point for the role of mathematics in Deleuze's thought erases Deleuze's engagement with the entire genealogy discussed above, despite its centrality to Deleuze's ontology and to the development of topological thinking in mathematics. In fact, DeLanda sums up the role and history of

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[143] On the two different approaches to the calculus; the Leibnizian and the Newtonian, see ibid., 11–13.

[144] See Manuel DeLanda, *Intensive science and virtual philosophy* (London: Continuum, 2005), 10–13.

differential calculus role in one paragraph, which does not include any reference to Leibniz or to any of the controversy associated with this history.[145]

I argue that this is a deliberate reconstitution of Deleuze's ontology, targeted to DeLanda's book's potential audience. DeLanda, in order to rehabilitate Deleuze and to make his work accessible to the rationalist scientific circles, has repackaged Deleuze, stressing *conventional* thinkers and methods. Inadvertently, this strategy has made Deleuze (and in the process, DeLanda's) work accessible to architectural students and theorists. However, I further maintain that the cost of such exposure is harmful, as it is part of the mechanism that converts Deleuze's concepts into a rationalist and axiomatic mind-set, which is counterintuitive to Deleuze's endeavour, as I sketched it above.

This becomes even more apparent when the two accounts of Duffy and DeLanda are juxtaposed. Both provide a mathematical account of Deleuze's concepts, but while the former maintains the mathematical rigour as well as the ontological context, the latter remakes Deleuze while clearing him of any metaphysics and paving the way to the current state of the discourse – and, by that, I mean to the full immersion of differential processes into essentialist cognition. This immersion operates in practice as well as in theory, for it is DeLanda who is being referenced by a wide range of architectural history and theory accounts of topology.[146] While I acknowledge the merit of DeLanda's work in illuminating some of Deleuze's mathematical concepts and their historical background (especially around the genealogy of topological thinking, and therefore I use his work on Gauss, Riemann and Poincaré below), I nevertheless rewire the connection established by DeLanda and reconnect topological thinking to its rightful forefathers – Leibniz and Maimon.

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[145] See DeLanda, Intensive science and virtual philosophy, 11.

[146] Other disciplines that overlap with architectural theory have adopted DeLanda as a source on topological thinking and social theory/ urbanism. See for example: Celia Lury, Luciana Parisi et al., "Introduction: the Becoming Topological of our Culture", *Theory, Culture and Society* 29 (2012): 7, accessed 20 January 2015, doi: 10.1177/0263276412454552. '[W]e choose to start with the work of mathematicians Karl Friedrich Gauss and Bernard Riemann in the second half of the 19th century who developed methods that allowed the study of n-dimensional surfaces without any reference to a supplementary embedding space-time – that is, surfaces that are spaces in themselves (DeLanda, 2005). Put simply, a surface that is a space in itself is not fixed by way of external co-ordinates but is, rather, organized from within itself; it has intrinsic rather than extrinsic dimensions.'

***The Introduction of Multiplicity – Ontological and Epistemological
Brief Alignment***

Gauss and Riemann's theory of the manifolds
DeLanda frames Gauss and Riemann's contribution as adding to the discussion
on the question of *multiplicity*, a Deleuzian term, which, according to DeLanda's
account, 'specify the *structure of space of possibilities*, space which, in turn,
explain the regularities exhibited by morphogenetic processes' (DeLanda 2002,
10, original emphasis), which in turn is designed to break the circle of essence of
process. However, DeLanda discusses Gauss and Riemann's contribution in
complete disembodiment from the trajectory they form part of and while erasing
an entire page from the history of mathematics and from the importance
multiplicity plays in Deleuze's thought. DeLanda refers to Gauss and Riemann as
the developers of *differential geometry*.[147] Nonetheless, and despite this
deliberate discontinuity in the history of the differential relations, his account of
Gauss' mathematical contribution is a viable one and I will briefly turn to it for a
description of his mathematical achievement. I will then re-link, or rather embed
it, as part of the non-dualist revolution ignited by Leibniz.

In the early nineteenth century, Gauss resurrected the curve from the Cartesian
system of fixed coordinates and approached its calculation by applying the
differential calculus, which:

> allowed the study of the surface *without any reference to a global
> embedding space.* Basically, Gauss developed a method to implant the
> coordinate axes on the surface itself […] and, once point had been so
> translated into numbers, to use differential (not algebraic) equations to
> characterize the relations. As the mathematician and historian Morris
> Kline observes, by getting rid of the global embedding space and dealing
> with the surface through its own local properties Gauss advanced the
> totally new concept that *a surface is a space in itself* (DeLanda 2002, 12,
> original emphasis).

Duffy expands on the significance of Gauss's contribution, according to which
'curvature is an intrinsic property of a surface that depends solely on how

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[147] See DeLanda, 10.

distances are measured on the surface itself rather than on the particular way in which the surface is embedded in space' (Duffy 2013, 103).

Riemann's contribution, also known as *qualitative multiplicity* is a further development of the idea of studying a surface in itself from 2D to N-dimensional surfaces or spaces, explains DeLanda: 'it is these N-dimensional curved structures, defined exclusively through their intrinsic features, that were originally referred to by the term "manifold"' (DeLanda 2002, 12).[148] A bold move, claims DeLanda, as its implication was that these spaces could have been analyzed without the need to embed them into a Euclidean space. Quoting Morris Kline who asserts that Riemann's leap was far beyond an extension to Gauss's differential geometry, it revolutionized the whole approach to the analysis of space. DeLanda, although pointing to the significance of this move, nevertheless removes it from the historical debate and from any reference to Leibniz's metaphysics.

This history is mentioned in a publication that is by no means linked to Deleuze's philosophy of difference. In *A History of Mathematics*, the writers situate Riemann's achievement not only as an 'ingenious scheme of uniformizing a function […]' but also as part of the centuries-old dispute in regard to the finite/ infinite interpretation of the calculus, while they compare his achievement with the work of the Weierstrassian school (as mentioned above, Weierstrass vindicated Newton's interpretation of the calculus), while removing geometry as well as the infinitesimal from its calculation. 'Here we see the most striking aspect of Riemann's work – a strongly intuitive and geometric background in analysis that contrasts sharply with the arithmetizing tendencies of the Weierstrassian school' (Boyer 2011, 528).

DeLanda does though reapply Riemann's analysis in Deleuze's work, claiming that it led Deleuze to a new theory of the genesis of physical forms, which is another inaccuracy, Riemann being part of a lineage of thinkers and

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[148] This use of cartographic terminology is no accident; Riemann was influenced by Gauss, his teacher, who alos worked in land surveying. See Arkady Plotnitsky, *Algebras, Geometries and Topologies of the Fold*: Deleuze, Derrida and Quasi-Mathematical Thinking (with Leibniz and Mallarmé)", in Paul Patton et al., ed., *Between Deleuze & Derrida* (London: Continuum) 2003, 101.

mathematicians referred to above and not an isolated event. Moreover, and again in order to cater to his audience, DeLanda embeds multiplicity in a physical process, coming from dynamic systems, as a model of 'material reality'.[149] I reject these examples as means to explain the importance or even applicability of the Deleuzian concepts. Therefore, in this account of Riemann, I limit my referents to DeLanda's mathematical explanations only, and turn to Deleuze for elaboration on how these notions fit into his concepts.

Figure 19: The Riemann Hypothesis popularized

As early as *Difference and Repetition,* Deleuze attributes to Riemann's mathematics the means to defy Euclidean geometry:

> Moreover, there is no revolution so long as we remain tied to Euclidean geometry: we must move to a geometry of sufficient reason, a Riemannian-type differential geometry which tends to give rise to discontinuity on the basis of continuity, or to ground solutions in the conditions of the problems (Deleuze 1968 [2004], 201).

In *A Thousand Plateaus,* Deleuze and Guattari expand on this mechanism, crediting Riemann with the beginning of topology, and consequently, the end of

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[149] See DeLanda, 13.

dialectics in mathematics: 'It was a decisive event when the mathematician Riemann uprooted the multiple from its predicate state and made it a noun, "multiplicity." It marked the end of dialectics and the beginning of typology and topology of multiplicities' (Deleuze and Guattari 2004 [1980], 532–3).[150] It is important to explain that multiplicity is first and foremost considered in terms of divisibility – rather than homogeneity. Not only when Deleuze discusses the mathematical model of smoothness in *The Fold,* but earlier in *A Thousand Plateaus,* when discussing the technological model, Deleuze discusses patchwork and equates it with Riemann spaces. Riemann therefore frames the smooth mathematical space.

> Riemann spaces are devoid of any kind of homogeneity. Each is characterized by the form of the expression that defines the square of the distance between two infinitely proximate points […] It follows that two neighboring observers in a Riemann space can locate the points in their immediate vicinity but cannot locate their spaces in relation to each other without a new convention. Each vicinity is therefore like a shred of Euclidean space, *but the linkage between one vicinity and the next is not defined and can be effected in an infinite number of ways. Riemann space at its most general thus presents itself as an amorphous collection of pieces that are juxtaposed but not attached to each other* […] Riemannian space is pure patchwork. It has connections, or tactile relations. It has rhythmic values not found elsewhere, even though they can be translated into a metric space. Heterogeneous, in continuous variation, it is a smooth space, insofar as smooth space is amorphous and not homogeneous (ibid., 535–6, original emphasis).

It is important to note that this contribution was made within geometrical premise, and can therefore be seen as continuing the line of discussion that Leibniz had begun, and which was proved non-rigorous from algebraic perspective. Plotnitsky goes so far as to frame this shift in ontological terms; accordingly, smooth space can be described by geometrical/ topological means while the algebraic lends itself more easily to the articulation of metric space.[151] The coming discussion on Poincaré's contribution dispels this dichotomy.

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[150] As part of their discussion of the importance of the notion of multiplicity in *A Thousand Plateaus*, Deleuze and Guattari turn to Bergson's theory of multiplicities as fluctuating between continuous and discrete, from multiplicity to metric, '*striated and smooth*'. See details above.

[151] See Plotnitsky, 106.

Poincaré: a bridge between the Leibnizian calculus and early topology

I now move on to the contribution of Poincaré to the history of the development of calculus and its codification as topology. When summing up Poincaré's contribution to Deleuze's work, DeLanda again places him outside of the calculus lineage, while focusing on the technicality of his theory. Poincaré's contribution to this genealogy becomes clear when we look again at *History of Mathematics* where the writers analyze his contribution to the theory of differential equations, a subject, they claim;

> runs like a thread through most of his [Poincaré's] work, he commanded that analysts had faced three major problems since the establishment of the calculus: the solution of the algebraic equations, the integration of algebraic differentials, and the integration of differential equations. He observed that in all three cases, history had shown that success lay not in the traditional attempts at reduction to a simpler problem but in a head-on attack on the nature of the solution (Boyer 2011, 550–1).

The significance of questioning the epistemological as well as the ontological nature of the mathematical problem is made very clear when the writers refer directly to the dispute I describe above – that between the finite and the infinitesimal interoperation of the calculus:

> In the second case [the integration of algebraic differentials], the attack on algebraic differentials, success had been achieved for several decades *by those who no longer attempted a reduction to elementary functions but used the new transcendental functions. Poincaré had been certain that a similar approach would aid with previously intractable problems in the solution of differential equations* (ibid., my emphasis).

The writers credit Poincaré with anticipating twentieth-century interest in topology.[152] It is interesting to note that the writers describe both Poincaré and Riemann as '*intuitionists* with sound judgment' (ibid., 553, my emphasis), elaborating further on the continuity Poincaré's work shares with Riemann, later to become twentieth-century algebraic topology, namely, 'treating a figure as an *n*-dimensional manifold and considering the order of connectedness' (ibid.).

Duffy elaborates on Poincaré's contribution as shifting the focus from the study

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[152] See Ute C. Merzbach and Carl B. Boyer, *A History of Mathematics* (New Jersey: John Wiley & Sons, 2011), 552.

of singularity itself to that of the entire curve. This entails the 'initial investigation of the geometrical form of the curves of functions with infinite branches, only then was numerical determination of the values of the function able to be made' (Duffy 2013, 27). Opposed to set theory that was prevalent in continental mathematics in the nineteenth century, Poincaré denounces its advocator, Cantor and his theory, on the premise of eliminating the differential relation between points and operating instead on the basis of discrete sets of numbers. Parisi and Lury, in their study of the coming of age of a culture of topology, elaborate further on this dispute and remind us that Poincaré 'famously claimed that set theory was the disease of the 19th century, put set-topology or the problem of the mathematical formalization of the continuum, into question':

> According to Poincaré, topology could and should thus be concerned with the qualitative rather than quantitative aspects of mathematics: the qualitative integration of differential equations, he argued, would define a topological continuum more effectively than discrete set-topology. For Poincaré, the uniform continuity of 4-D manifolds was to be explained in terms of qualitative transformation and infinitesimal connectedness of the sets or states of experience rather than by discrete spatiotemporal sets isolated from one another' (Lury and Parisi 2012, 22–3).

Poincaré's topology is defined not by finite points but where these points are part of a *field of vectors*, where he focuses on the study of the intrinsic qualitative aspects of spatial configuration that remain invariant under continuous one-to-one transformations. This account is retold in *Introduction: The becoming Topological of Culture* by Celia Lury, Luciana Parisi and others,[153] but, once again, this account is missing the long history at the basis of this debate and the ontology it represents, as explained by Deleuze in *The Logic of Sense*:

> This surface topology, these impersonal and preindividual nomadic singularities constitute the real transcendental field. The way in which the individual is derived out of this field represents the first stage of the genesis. The individual is inseparable from a world; but what is it that we call 'world'? In general, as we have seen, a singularity may be grasped in

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[153] See Celia Lury, Luciana Parisi et al, "Introduction: the Becoming Topological of our Culture", *Theory, Culture and Society* 29 (2012): 22–3, accessed 20 January, 2015, doi: 10.1177/0263276412454552.

> two ways: in its existence and distribution, but also in its nature, in
> conformity with which it extends and spreads itself out in a determined
> direction over a line of ordinary points (Deleuze 2015 (1969), 126).

Duffy argues that developments in mathematics of the twentieth century
required the calibration of Leibniz's metaphysics offered by Poincaré: 'What
Poincaré's qualitative theory of differential equations does is offer a way for the
part–whole structure of Leibniz's metaphysics to be problematized and
overcome' (Duffy 2013, 42). This bears on the capacity of Leibniz's monad to
contain the entire world,[154] as well as on the distinction between compossible
and incompossible worlds, as the logical possibilities of all incompossible worlds
are now real possibilities able to be actualized by monads. *The monads are being
replaced by the essential singularity in the Deleuzian account as the elements that
bring unity to the multiplicity of parts of matter*.[155] Duffy further explains:

> The essential singularity fulfills the role of accumulating or condensing
> the preindividual singularities if the discontinuous analytic functions. It is
> the number of mathematical points, *points of view,* or *preindividual*
> singularities coincident at any time in the essential singularity that
> corresponds to the proportion of the world that is expressed clearly and
> distinctly as the conscious perception of an individual subject' (ibid., 43,
> my emphasis).

Therefore, the importance of Poincaré to Deleuze and to *The Fold* is in
connecting singularities to a field, but not from the point of view of its continuity,
its endless malleability, which is the emphasis DeLanda makes, but in realizing
the infinitesimal in his mathematical analysis and the ability to hold both to the
singular and to the infinitesimal without resulting in the universal. From an
ontological perspective, the world is no longer established on the premise of
Leibnizian harmony, and Poincaré's solution overcomes this incompossibility of
that world.

From Monadology to Nomadology

What is the significance of Gauss, Riemann and later Poincaré's contribution to
Deleuze's thinking? Their contribution should be viewed as not only developing

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[154] Duffy refers here to Deleuze, *The Fold*, 157.
[155] See Duffy, 42.

the mathematical thinking behind topology, their contribution is far greater than this, for it is with Gauss and Riemann shifting the calculus back to the realm of geometry that they have managed to pose the problem in such way that made it possible later for Poincaré to propose a 'rigours' topological-algebraic solution. This has resurrected the infinitesimal from declining into an idealist Baroque universe. This is, however, an ontological qualification, for it is this moment in the history of the calculus that the epistemological and ontological come together, which is precisely what they allowed Deleuze for. This brief moment in the history of the calculus has allowed for the monad to be opened up in terms of its point of individuation to articulate the manifold (which Deleuze equate with multiplicity). Multiplicity has become a mathematical reality, while keeping with the infinitesimal, which means that the singular has been maintained, not in a universal way, but rather, and more significant for this thesis, in keeping with Leibniz's point of views, which is to say, in keeping with a point of preindividual embodiment.

Gauss and Riemann and to a greater extend Poincaré's contribution is in realizing singularity without falling to a pitfall of universalism. The significance of Poincaré's qualitative theory of the differential equation is in opening up the monad – 'the world is no longer contained in each monad. There is no pre-established harmony. The continuity of the states of the actual world and the discrimination between what is compossible and what is incompossible with this world is no longer predetermined' (Duffy 2013, 42). By developing the qualitative differential Poincaré allows for an extension to unlimited worlds, which meant a break from Leibniz's pre-established harmony, the ideal world that God has chosen for all monads which they all share, (with the limitation of perception). Therefore, this is the moment when monadology assumes itself as nomadology, a transition with which Deleuze closes *The Fold*, and I quote:

> we have now a new Baroque and a neo Leibnizianism. The same construction of the point of view over the city continues to be developed, but now is neither the same point of view nor the same city, now that both the figure and the ground are in movement in space. Something has changes in the situation of monads between the former model, the closed chapel with imperceptible openings, and the new model invoked by Tony

> Smith, the sealed car speeding down the dark highway. In summary we can attribute what has changed to two principle variables (Deleuze 2006 [1988], 157).

The harmony that was at the base of Leibniz's hermetic world is no more, and with it disappeared the main principle that enabled it, the incompossibility of the world, which meant that God chose this world for us, and it is being enclosed in each and every monad. With the notion of multiplicity introduced, and especially since Poincaré made it impossible to maintain the purity of this world amidst potential other worlds, Deleuze dissolves the monad.

> To the degree that the world is now made up of divergent series (the chaosmos), or that crapshooting replaces the game of Plenitude, the monad is now unable to contain the entire world as if in closed circle that can be modified by projection. It now opens on a trajectory or spiral in expansion that moves further and further away from a centre (ibid., 158).

The field has changed and the harmony is gone, but the motion in itself is still unchanged, as Deleuze concludes:

> We are still Leibnizian, although accords no longer convey our world or our text. We are discovering new ways of folding, akin to new environments, but we all remain Leibnizian because what always matters is folding, unfolding, refolding' (ibid.).

In order to fully understand this convergence between monadology and nomadology we need to look for the significance of the notion of multiplicity to Deleuze's – Why is it that the development of multiplicity replaces monadology? Can we equate nomadology with multiplicity? And why it replaces any concept of harmony? What is the correspondence between multiplicity and the infinitesimal? When looking to other texts by Deleuze, multiplicity asserts itself as a thread that reappears assuming different guises, but with a consistent role, a mechanism to undo dualism and unity. Deleuze gives us a hint to why he peruses both in a text removed from the question of the mathematical, and removed form Baroque or Leibniz. The importance of *multiplicity* to Deleuze as a non-dualist concept, later to frame his conception of nomadology is highlighted as early as *Difference and Repetition*, where this concept is being discussed in relation to ideas, as that which is not the one, in direct reference to Riemann,

> Ideas are multiplicities: every idea is a multiplicity or a variety. In this Riemannian usage of the work "multiplicity" (taken up by Husserl, and again by Bergson) the outmost importance must be attached to the substantive form: multiplicity must not designate a combination of the many and the one, but rather an organization belonging to the many as such, which has no need whatsoever of unity in order to form a system. The one and the many are concepts of the understanding which make up the overly loose mesh of a distorted dialectic which proceeds by oppositions [...] instead of enormous oppositions between the one and the many, there is only the variety of multiplicity – in other words, difference (Deleuze 2004 [1968], 230).[156]

In *The Logic Of Sense*, Deleuze puts multiplicity in direct relation to the concept of the infinitesimal as he goes back to Lucretius and to his thinking about naturalism juxtaposed with the power of negation. It is not the definition of naturalism that I am interested in, but in how Deleuze positions an idea of extension and multiplicity with affirmation, and I quote:

> Naturalism makes of thought and sensibility an affirmation. It directs its attack against the prestige of the negative; it deprives the negative of all its power; it refuses to the spirit of negative made an appearance out of the sensible; and linked to the intelligible to the One or the Whole. But this Whole, this One, was but nothingness of thought, just as the appearance was a nothingness of sensation. Naturalism, according to Lucretius, is the thought of an infinite sum, all of the elements of which are not composed of once; but conversely as well, it is the sensation of finite compounds which are not added up as such with one another. In these two ways, the multiple is affirmed. The multiple as multiple is the object of affirmation, just as the diverse as diverse is the object of joy. The infinite is the absolute intelligible determination (perfection) as a sum, which does not form its elements into a whole. But the finite itself is the absolute sensible determination (perfection) of everything which is composed. The pure positivity of the finite is the object of the senses, and the positivity of the veritable infinite is the object of thought. There is no opposition between these two points of view, but rather a correlation (Deleuze 2015 [1969], 315).

Another example of the importance of multiplicity in the construction of a non-

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[156] Although the concept of multiplicity as a non-dialectic notion is mentioned in other occasions throughout *Difference and Repetition* this is the only reference Deleuze makes to Riemann. Riemann is absent from The Fold, but does appear in *A Thousand Plateaus* already in the context of nomadic space (see below). Deleuze draws extensively on Riemann as a point of reference in *Bergsonism*, see Duffy *Deleuze and Mathematics,* 107–115.

dualist, non-representational world to Deleuze is in *Bergsonism,* where Riemann's work on qualitative multiplicity is referred to by Deleuze as an example of duration understood in spatial terms, again in the context of difference thought away from the negativity of dialectics. Duffy is explicit about the two mathematical concepts developed by Riemann that Deleuze draws upon in the context of Bergson: *Riemann space* and *Riemann surface.*[157] Riemann surface is 'a two dimensional real surface composed of different sheets that are mappable onto the complex plane' as a means of making sense of 'many valued functions', and as a result 'there is more than one way of defining them': 'Riemann surfaces are constructed by combining the sheets of these different branches geometrically, i.e. by joining the sheets of the different branches of the function together, such that the sheet of one branch of the function joins continuously with that of another branch of the function, to obtain a geometric surface on which the function is well defined and single value' (Duffy 2013, 108).[158] Riemann space on the other hand 'provides a new way of conceiving the relations between Riemann surfaces […] and the essential singularities they represent value' (ibid., 114). Riemann surfaces are comprised of Riemann spaces.

Arkady Plotnitsky goes so far as to argue that it was Leibniz who formulated topology, later to be developed into the modern topology of the nineteenth century with the work of Gauss, Riemann and Poincaré.[159] The terminology here is of less importance than the calling out of this lineage of mathematicians in relation to the development of current topology while bypassing the finite branch of the calculus. Plotnitsky mentions the importance of Riemann's manifold/ multiplicity in the articulation of smooth space in *A Thousand Plateaus* (quoted above) especially to the articulation of space away from the Cartesian grid as the 'end of dialectics and the beginning of a typology and topology of manifolds' (Plotnitsky 2003, 101).[160] It is Riemann's analysis of space that allows for the articulation of a smooth space in *A Thousand Plateaus* concludes Plotnitsky. 'The mathematical model of the smooth in Deleuze and Guattari's

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[157] See Duffy, *Deleuze and Mathematics*, 107–8.
[158] Duffy further explains how Riemann surface was then taken up by Weyl in 1913, who gave it a rigorous formulation, which is beyond the scope of this work. See ibid., 108–12.
[159] See Arkady Plotnitsky, *Algebras, Geometries and Topologies of the Fold*, 99–100.
[160] His account omits the role Poincaré plays altogether.

sense is defined by the topology of the differential manifold' (ibid., 103). The shift from monadology to nomadology is framed by a movement from the vertical to the horizontal, alluding to Riemann;[161] this shift, argues Plotnitsky, 'is also marked by a shift of emphasis [...] on a certain 'algebra' [...] vs a more pronounced geometrical/ topological character of Deleuze's rendition of the vertical, hierarchical Baroque. The h*orizontally* geometrical/topological determination itself appears to remain dominant' (ibid.,106).

With the shift to multiplicity, to the nomad, Leibnizianism does not, however, cease to fascinate Deleuze – that would mean throwing the baby out with the bath water, for 'we are still all Leibnizian'. This is to say that while the structure of the world has changed, the mechanism of relationality has not. From the point of view of this thesis this means that since folding unfolding and refolding are still fundamental, so is the mechanism that allowed for arriving at a point of view – I pursue this point in the closing section of this cartography.

This moment of alignment between the epistemological and the ontological was, however, shortlived, for it is Robinson's non-standard analysis that annuls the ontology of the infinitesimal by embedding the calculus into a static, universal world. That is to say that although Robinson's claim to vindicate the infinitesimal is epistemologically sound; ontologically, however, this is not the case.

Non-standard analysis and the loss of the infinitesimal

In his book, *Non-standard Analysis,* the mathematician Abraham Robinson indicates to have resolved the dispute surrounding the inclusion of the infinitesimal as part of an algebraic solution to the calculus as he states in the introduction:

> G. W. Leibniz argued that the theory of infinitesimals implies the introduction of ideal numbers which might be infinitely small or infinitely large compared with the real numbers but which were *to possess the same properties as the latter*. However, neither he nor his disciples and successors were able to give a rational development leading up to a system of this sort. As a result, the theory of infinitesimals gradually fell into disrepute and was replaced eventually by the classical theory of

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161 Plotnitsky, 105.

limits. It is shown in this book that Leibniz' ideas can be fully vindicated and that they lead to a novel and fruitful approach to classical Analysis and to many other branches of mathematics. The key to our method is provided by the detailed analysis of the relation between mathematical languages and mathematical structures which lie at the bottom of contemporary model theory (A. Robinson 1966 [1974], 2).

The mathematical historian Bell arrives at a similar conclusion in regard to the infinitesimal as vindicating Leibniz's theory:

> In recent years, the concept of infinitesimal has been refounded on a solid basis. First, in the 1960s Abraham Robinson, using methods of mathematical logic, created nonstandard analysis, in which Leibniz's infinitesimals – conceived essentially as infinitely small but nonzero real numbers – were finally incorporated into the real number system without violating any of the usual rules of arithmetic (see Robinson, 1966). And in the 1970s startling new developments in the mathematical discipline of category theory led to the creation of smooth infinitesimal analysis, a rigorous axiomatic theory of nilsquare and nonpunctiform infinitesimals. As we show in this book, within smooth infinitesimal analysis the basic calculus and differential geometry can be developed along traditional 'infinitesimal' lines – with full rigour – using straightforward calculations with infinitesimals in place of the limit concept (Bell 1998, 4).

This argument, however, is rejected by Deleuze himself. In the first section of this cartography, discussing the role mathematics plays in Deleuze's work, I mentioned that the infinitesimal analysis is philosophically possible precisely because it is a mathematical non-reality. How can the existence of the one be maintained now that the infinitesimal is claimed to be a reality? Deleuze's direct comment on Robinson does not amount to more than one sentence, in the closing chapter of *The Fold*; it is in the framing of Robinson's analysis, however, that we gain an understanding of his position. Robinson's analysis is made part of a discussion on the particular nature of harmony as Leibniz envisaged it, which does not conform to the hypothesis of universal spirit, but rather is irreducible to particular units. His work is framed in the following way:

> The mathematician Abraham Robinson has proposed considering Leibniz's monad as an infinite number quite different from transfinites, as a unit surrounded by a zone of infinitely small numbers that reflect the

> convergent series of the world. And the point is effectively that of knowing how the unit of a numerator is at once combined with the infinite denominator, but with distinctive variable value [...] Each monad includes the world as an infinite series of infinitely small units, but establishes differential relations and integrations only upon a limited portion of the series, such that the monads themselves enter an infinite series of inverse numbers. In its own portion of the world or in its clear zone, each monad *thus presents accords,* inasmuch as an 'accord' can be called the relation of a state with its differentials, that is, with the differential relations among infinitely small units that are integrated into this state (Deleuze 2006 [1988], 149).

In his Leibniz seminar Deleuze is more explicit about the claim for the two, the infinitesimal to exist in current-day differential calculus.

> Mathematically, today, differential calculus has purged itself of any consideration of the infinite; the kind of axiomatic status of differential calculus in which it is absolutely no longer a question of the infinite dates from the end of the 19th century (Deleuze, Vincennes Session, Leibniz Seminar 22 April 1980).

Duffy confirms that the two analyses, those of Leibniz and Robinson, do not share the same idea of the infinitesimal: Robinson's infinitesimal is a static quantity and does not prove Leibniz's infinitesimal.[162] However, argues Duffy, what is vindicated is the introduction of the idea of the infinitesimal to the differential calculus, a concept that mathematicians have rejected for centuries. In this sense 'the proofs are inspirational rather than demonstrative. What Robinson's proof represents is the end of any legitimacy in the impetus to bury the infinitesimal once and for all' (Duffy, 166).

Deleuze reminds us that Leibniz envisages the infinitesimal, as the potentiality of expression of each monad, the potentiality to differentiate, to become, to individuated, to gain a clear perspective in relation to another monad, a clear perspective as part of an infinitesimal fuzziness, while Robinson's non-standard introduces a universal element to the differential. Against this background it is clear that 'vindicating Leibniz' is in relation to the mathematical aspect of the calculus, but can the philosophical notion be maintained by adhering to a seemingly identical mathematical concept? Migayrou's assertion that the non-

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[162] See Duffy, 165.

standard analysis had realized in digital terms the potential of Deleuze's theory is therefore based on the mathematical analysis only, and as I argued in the previous chapter, this stand does not take into account the ontological aspect of this debate.[163] In the above-mentioned AA lecture, Migayrou traces a lineage of non-standard analysis initiated by Robinson and realized through his colleagues and students, from Mandelbrot, a mathematician who is best associated with fractal theory, through to his student René Thom, who could not have developed his catastrophe theory without non-standard analysis. Therefore, non-standard analysis underpins current digital procedures. [164]

Non-standard therefore injects universalism back into a zone, which was not only extended ad infinitum but also embodied and therefore singular. This dual act that the infinitesimal enabled in the calculus, which was achieved at the turn of the century disappeared again from mathematics. With the evacuation of the ontology of the infinitesimal from topology, what are we left with?

Back to Universal Ideas: The Unconscious Codification of Digital Architectural Thought

Forgetting the infinitesimal – maintaining smoothness

In this section I account for the history of topology as it emerges in the mathematically oriented digital architecture discourse of George Legendre, Mark Burry, Antoine Picon and Manuel DeLanda. Their narratives do not dispute the pivotal role of topology as underpinning digital computation in architecture, and especially parametricism. Before I turn my attention to parametricism, I discuss the prevalent mathematical genealogy of their histories as overwhelmingly biased towards a rationalist, finite genealogy of topology.

Legendre's guest-edited AD *Mathematics of Space* (2011), dedicated in its entirety to the mathematic underlayer of digital discourse, omits Deleuze's role from the development of topology and, as a consequence, strikes out an entire

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[163] See cartography 1, Narrative 1, Alternative Narratives; non-standard architecture section for Migayrou's stand on non-standard analysis.

[164] Duffy recalls Mandelbrot attributing Poincaré as 'the first student of fractal ("strange") attractors' that inspired his own theories, Duffy, 30.

minoritarian lineage which I traced above, the calculus in this publication being therefore striated.[165] In the introduction to this compilation, Legendre makes a general remark in regard to the seventeenth-century innovation in differential geometry: 'this new geometry of symbols and operators rather than lines and figures, which subtends our contemporary understanding of mathematics in space, and of course enables the recent innovations of computation' (Legendre 2011, 12). However, this is the extent of his engagement with this history. Legendre then gives the stage to other developments in *majoritarian* mathematics that outweigh this history.[166] An example of the rationalization of topology is enhanced by the contribution to this AD publication of a French historian of science, Amy Dahan-Dalmedico, who outlines a brief history of the mathematics of space whereby she creates a straight line from Descartes to the nineteenth century, bypassing entirely the genealogy of the differential.[167]

I have specifically discussed Manuel DeLanda's account on Deleuze and mathematics, mentioned above, which contextualizes Deleuze's mathematical thinking and his contribution to topology with rationalist scientific thinking of the twentieth century. This project is shared by Legendre in his effort to rationalize topology and, as a by-product, to rehabilitate parametricism as a purely scientific realm of research. These two examples attest to the tendency Deleuze and Guattari describe above – to the subsuming of the smooth by the striated.

Jane and Mark Burry in *The New Mathematics of Architecture* (2010) credit Deleuze with 'giving us the "body", any corporeal arrangement composed of an infinite number of parts that are held together when they move in unison' (Bury, Mark and Burry, Jane 2010, 10–1). In other words, they view topology, the

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[165] This alternative history reaches its height with Bernard Cache's paper on the seventeenth-century mathematician Desargues, Leibniz's contemporary, who developed projective geometry. Leibniz, according to Cache, studied projection before moving on to differentials as a means to anchor his mathematics on a sound foundation. This insinuates that the differential in itself was dubious and needed a clearer foundation. This is the only mention of Leibniz in this publication dedicated to the digital and mathematics. See Bernard Cache, "Desargues and Leibniz: In the black Box – A Mathematical Model of the Leibnizian Monad" *Architectural Design: The Mathematics of Space* 81(2011): 90–9.

[166] See George Legendre, "The Mathematics of Sensible things", introduction to *Architectural Design: The Mathematics of Space* 81(2011): 11–12.

[167] See Amy Dahan-Dalmedico, "Mathematics and the Sensible World, representing, constructing, simulating", *Architectural Design: The Mathematics of Space* 81(2011): 23–7.

system that underpins digital computation in architecture, as directly inspired by Deleuze's concepts, as promoting spatial continuity. However, their focus is not on the histories of this mathematics, but to account for the relationship between the new mathematics and digital architecture since the mid-1990s.

Antoine Picon's approach is a call to eliminate the smooth from the striated altogether, precisely because of the consequences of such subsuming processes; calculus, claims Picon in his 'Architecture and Mathematic; between hubris and restraints', is responsible for estranging architecture from mathematics.[168] He locates the roots of this shift in the eighteenth century, upon introduction of the calculus to mathematics –the calculus Picon goes on to argue was proved too complex for non-mathematician architects. The re-enumeration of architects with mathematics, and with the calculus is enabled by the introduction of the computer to architecture; the result, according to Picon, is the lack of restraint (*hubris*) in the digital architectural world today.[169] Topology, Picon asserts in another publication, is the mathematics of singularities and thus the mathematics of the spectacle.[170]

I argue to the contrary: while it is correct that, in its origin, as I have demonstrated above with Riemann and Poincaré's projects, the emphasis was on singularities, the latter is no longer the model of smoothness when it comes to the digital. This brings me to my next point – that of the conflation between smoothness as a striated concept of space that proliferates in digital discourse and between smoothness in the Deleuzian sense (which incorporates Riemann and Poincaré's complexity) – but first I turn to explain this distinction, which takes me back to Picon's conclusion. I discuss his assertion on the future of digital architecture in the first chapter in general terms, we can now imbed the general discussion in the mathematical debate it relates to. Picon identifies this situation of a perceived architectural lack of restraint as reversible with the reintroduction of a standard to architecture as a means to confine digital hubris. Proposing to introduce a standard back into architecture is in effect a

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[168] This paper is published as part of Legendre's *Mathematics of Space* (2011).
[169] See Antoine Picon, "Architecture and Mathematic; between hubris and restraints", *Architectural Design: The Mathematics of Space* 81(2011): 33. I discuss Picon's assertion in Cartography 1, Narrative 2.
[170] See Antoine Picon, *Digital Culture in Architecture* (Basel: Birkhäuser, 2010), 65.

proposition to revert to Euclidean mathematics that operate a standard, and to discard the digital project altogether. This is one of the dangers I see in this state of hybridity, which leads, in the case of Picon to the misplacing of topology with hubris, rather than accounting for the causes of hubris in the lingering association of topological practices with the same humanist traditions that bring us a standard. It is not the formal exuberance that I find problematic, but rather the masking effect of this so-called relationality.

Leibniz and Deleuze's project of the calculus, as I have discussed above, was about derivation, about the act of differentiation that gave shape to the fold; this project has reversed its emphasis mathematically as well as ontologically – it is the curve, the fold, or the *parametric surface that now represents the function* – a static correlation. Developments in mathematics have muted the dynamism of the calculus that was enabled by a strive to the infinitesimal, and reintroduced the axiomatic of the function. The becoming of the curve, the fold, and later its 3D iteration – the surface through a study of relations that unfolds the determination of points that differentiate further ad infinitum, gaining clarity to determine singularities and fuzzing out again, deflecting from + to – from individuation to falling back to the mass – that quality was lost. We are left with the universal, the empty shell of the curve, frozen by its function. Striating the calculus, therefore, side-lined the relationality itself as the making of points of view (a concept that I expand upon in the closing section of this cartography), in favour of the formal continuity that is its outcome.

I turn now to the codification of topology into computation, in order to establish what further changes have triggered the turn to continuity in digital architecture. What is the connectivity between singularities and regular points on a curve, first developed by Gauss, and their development into b-spline, or rather as NURBS surface (non-uniform rational b-spline)? What is the process leading from the curved surface developed by Riemann, later to become parametric surfaces, enhanced by algorithmic sequencing, introducing the fourth dimension, that of time, packaged for the architectural world? It is the topological relations that operate what we come to know as parametric design.

Luciana Paris gives a computational explanation of how these relations are formed:

> Parametric design, for example, can be said to underpin many forms of topological operationality as it specifically works to programme mathematical relations between data sets. As the term 'parametric' implies, a parameter is a variable to which other variables are related. Hence sets of variables and their relationships determine the changes of a spatial form. While the initial conditions of the parametric design are still programmed through a binary of logic of 0s and 1s, these conditions are open to change through the evolutionary processing of parameters, when new variables are at once generated from and added to the set of initial values. Hence, *the continual relation of programmed variables is more important to the parametric design* [...] for instance, than the digitalization of physical variables into sets of 0s and 1s. This means that while, on the one hand, parametric relations order variables into sequential binary sets, they are also determined by the qualitative level of topological functions, *where differential relations explain how the transformation of one value is equivalent to the continual variation of the whole space* (Parisi 2012, 175, my emphasis).

This schism is enhanced further by the introduction of *Grasshopper*.

Grasshopper establishing parametricism hegemony; re-{con}forming
The path from the mechanism of differentiation to that of continuity has come to its peak with the introduction of *Grasshopper* to the architectural world. In this section, my main interest is in the software mechanism that enhances the transformation of the mathematical thinking behind digital architecture: from the differential to the continuous-hegemonic, focusing on the two aspects of the differential – the articulation of the infinitesimal (mathematically) and the articulation of singularities as markers of the differentiating mechanism. I argue that the very features of the software that appeal so much to architects are the same features that aid in striating topology. In the analysis of the software I refer to the *Grasshopper* manual by Arturo Tadeschi, entitled *Parametric Architecture with Grasshopper*, and to online tutorials and a first-hand account of the thinking behind the development of the software – a lecture by David Rutten (2010), the software inventor and developer.

Grasshopper: the quantification of architectural thought

The short architectural computation tradition has the tendency to treat the software matter of factly, as a protocol of use, a mechanical reality. The digital aspect of parametric architecture encompasses a general discussion and is not a specific site of enquiry, which results in a lacuna of any critical theory of the software itself. This is in direct opposition to the dependency on the software not only as a production tool, but also as a design engine. To supplement this need and as part of my cartography, *Grasshopper* is a site of enquiry to this thesis.

Grasshopper was developed for Robert McNeel & Associates, as a plug-in to the modelling software Rhino, by David Rutten, when he was an architecture student at Delft University of Technology (TU Delft). It was originally released in September 2007 and was run as a beta phase development before *Grasshopper* became part of the standard Rhino toolset. In a lecture Rutten gave at the AA (2010), he shared the background against which he developed the software, recalling his growing frustration as a second-year student of Architecture and Urbanism at TU Delft with the lack of scientific approach in the design courses:

> it seems that all designs were based on emotional or at best philosophical considerations, and I wanted to see numbers, I actually wanted a proof that a design is better than anything else, so I started programming to accomplish this (Rutten 2010).

I find this account of Rutten's academic background and his motivation for the later development of *Grasshopper* an interesting moment to dwell on, as it locates Rutten's positivist approach to be the main explanation behind the software's ethos – that of quantifying every aspect of the design process without, however, seeking to understand the deeper levels of mathematics, remaining instead at the architect-comfortable graphic domain of geometry in relation to immediate input of inflows of data.

> [A designer using Grasshopper] can define algorithmic sequences by connecting graphical objects called *components*. The *components* represent geometrical elements (points, curves, scalar quantities, vectors, surfaces etc.) and graphical operations (shifts, extrusions, deformation etc.) among which the user can set input/ output relations in order to generate three-dimensional models (Tedeschi 2011, 19).

This allows for '[...] a dynamic system of relation among different objects' (ibid., 17). The software's main appeal is its operation as a visual editor, using intuitive graphical methods based on nodes, an interface that does not require special mathematical nor scripting preknowledge, which was the barrier to accessing digital architecture until the mid-2000s. The mathematical functions as well as the computational scripts are all recessed to the background, muting entirely not only the functionality of its operation but also the distant history of mathematics I refer to above, and certainly its ontology, a lobotomy that has become the reality of a generation of architectural students especially with the growing popularity of the software, which was endorsed by Patrik Schumacher,

> Grasshopper seems to be winning out in the competitive struggle for domination as the preferred tool for scripting' precisely because the great advantage of Grasshopper is that it transposes most of the scripting syntax into a graphic network language [...] the choice and elaboration of systematic correlations between the variable elements of the design – is now brought back into the ambit of architecture's specialized medium of communication (Schumacher 2011, 354).[171]

The operation system: from differentiation to continuity

Grasshopper's working area, named *Canvas*, is used to arrange visual icons that operate as an algorithmic sequence. Canvas is not only a misleading and nostalgic reference, it is an allegory to the operating ethos behind *Grasshopper* as it flattens layers of complexity, mathematical, computational and the external flow of data to the surface of a visual white-grey, two-dimensional space. This simplification of the software and its portrayal as a *natural* surface for the emergence of creation leaves out the make-up of the software, its mathematics and algorithms that remain in the shade, as well as the assumptions that render them. The tools of creation are the *nodes*, which are called upon the canvas.

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[171] Grasshopper has also gained professional recognition: David Rutten has won an ACADIA innovative research award 2012, 1st Place: 'The selection of David Rutten for the award in Innovative Research recognizes his profound impact to architecture and computation as the developer of the Logical Modeling plug-in, Grasshopper, for the Rhinoceros 3D CAD application. Grasshopper has been pivotal to the transformation of parametric design practices over the past five-plus years' as quoted in: http://uk.archinect.com/DavidRutten?ukredirect, last accessed 20 November 2016. (Archinet People, Devid Rutten n.d.).
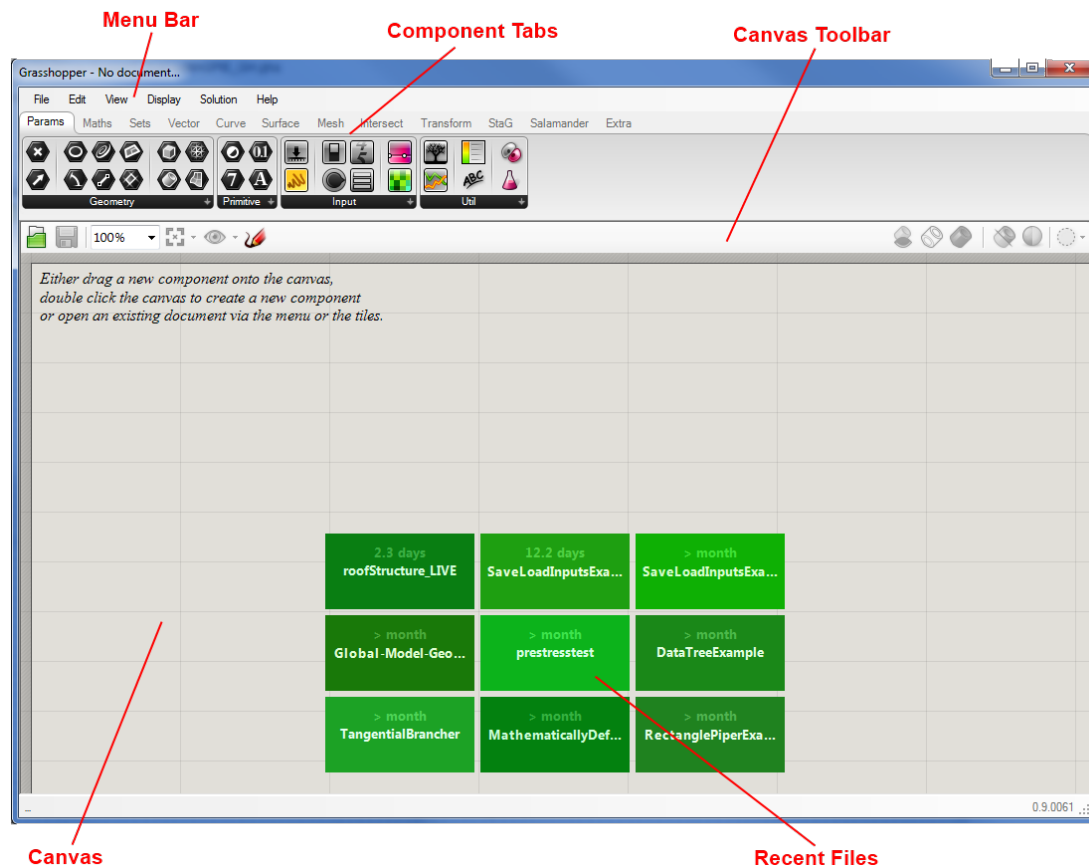
Figure 20: Grasshopper working Canvas[172]

> The components, the nodes (whether they are geometric or functional)
> are connected via dotted lines, known as *flexible* wires, which provide a
> graphical representation of the unidirectional flow of data from the
> output grip of one component to the input grip of another component […]
> The direct connection is the primary method of defining algorithmic
> sequence in Grasshopper (Tedeschi 2011, 28).

This interface composed of individual components comprises empty fields until
loaded with information, either functional or informational to a world of graphic
objects connected by graphic lines that convert to a geometrical object on a
Rhino screen – a Cartesian gridded one, superimposed.

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[172] Another source for Grasshopper tutorials is Jose Sanchez's web site; see: "Plethora –
Project" 20 November 2016. http://www.plethora-project.com/education/2012/02/05/rhino-
grasshopper/ The Grasshopper site contains a wealth of online resources and tutorials:
"Grasshopper Algorithmic modelling for Rhino", last accessed November 2016.
http://www.grasshopper3d.com/video/video/listTagged?tag=tutorial&sort=mostPopular.

Figure 21: Point parameter waiting to be assigned data
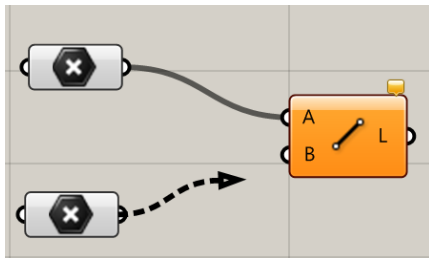
Figure 22: 2 point parameter assigned a specific coordinate and attached to a command (a line)
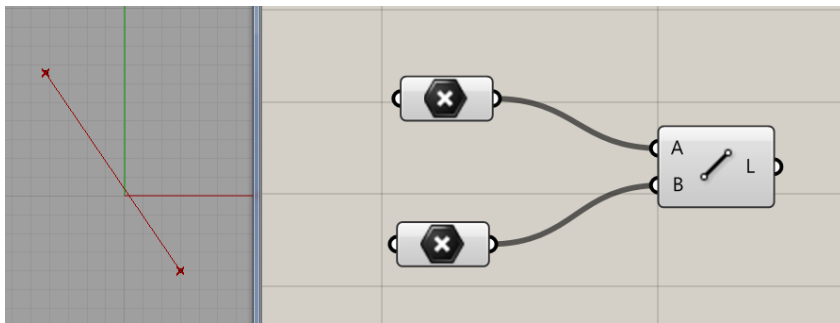
Figure 23: The translation of the line into Rhino
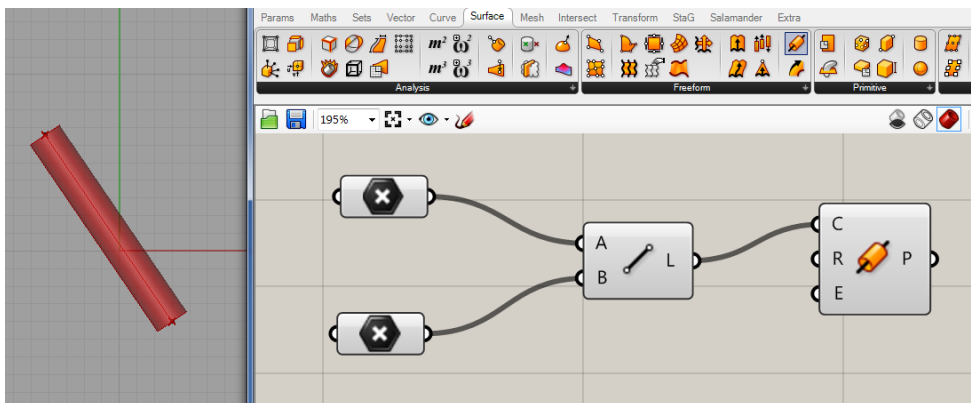
Figure 24: An example of the simplicity of operating the software, example 1: the manipulation of a line into tube
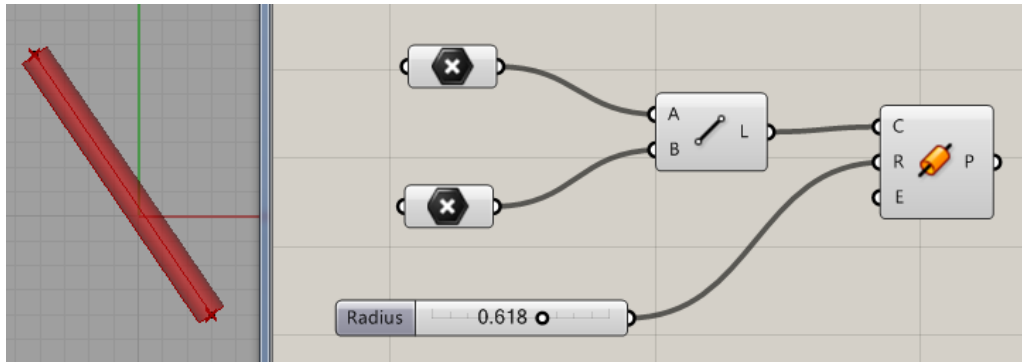
Figure 25: An Example of introducing a radios slider to the tube
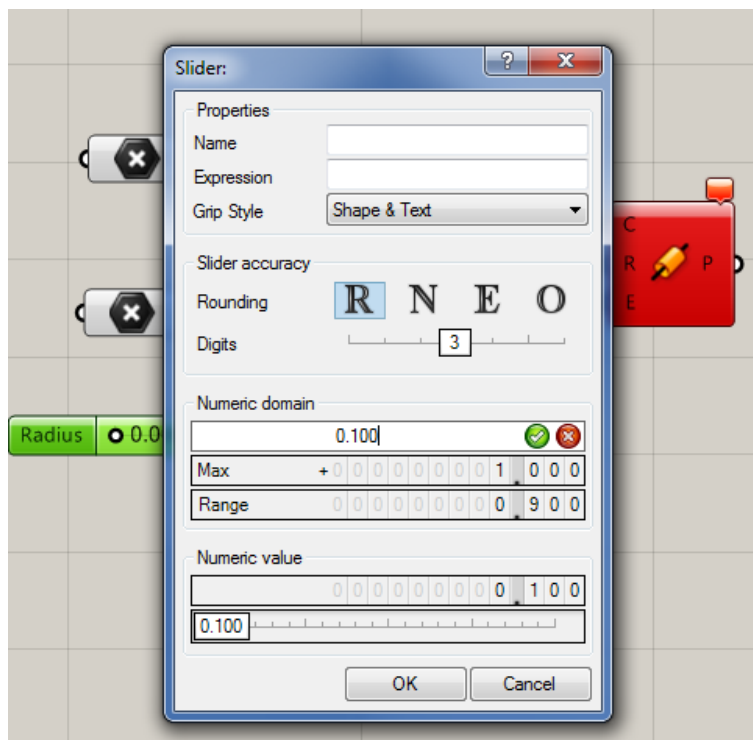
Figure 26: Slider control

Data can be associated with a parameter in a less fixed manner than seen in the example above through the introduction of *sliders,* which provide a range of possibilities. This enables a more associative modulation of the output, as it allows for variables. The slider accuracy is flexible; it intuitively changes a 3D surface, visually this operation is set to a predefined limit. The main advantage is the immediate effect of the visual change, of topology working its web of connections behind the scenes, none of which is visible to the designer.
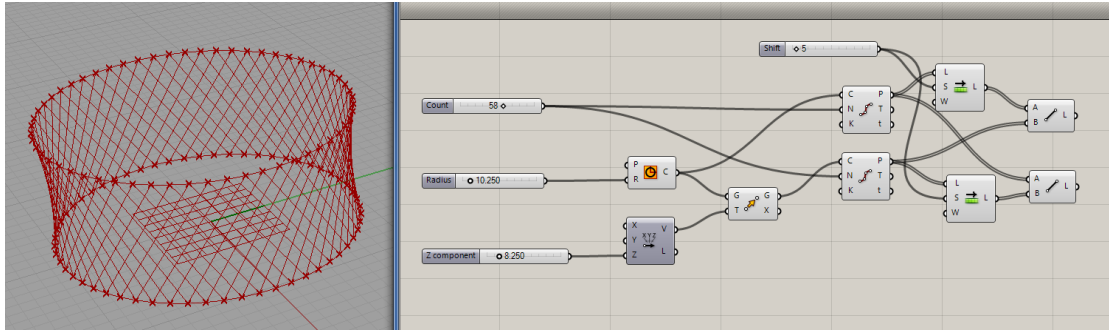
Figure 27: Formal manipulation via slider phase 1
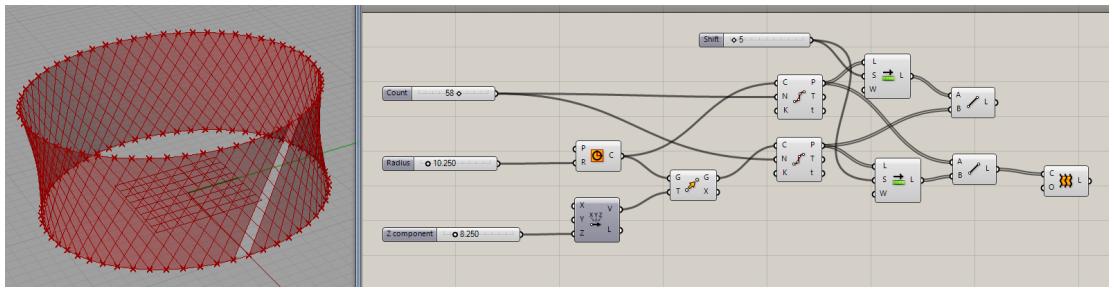
Figure 28: Formal manipulation via slider phase 2
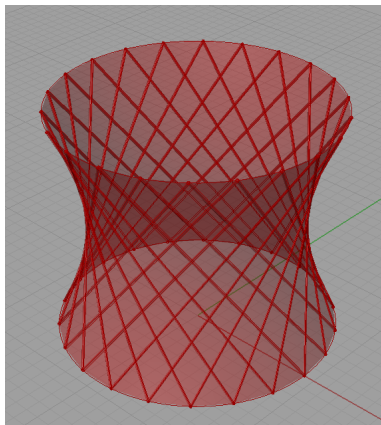
Figure 29: Phase 3
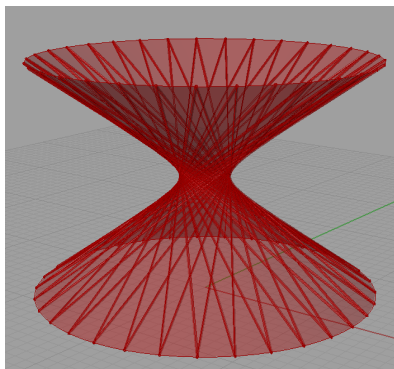
Figure 30: Phase 4

The introduction of a different temporality that operates outside of chronos is my next point in regard to sliders. It works by combining the spatial and temporal aspects of a design to a coordinated mesh. If we are to tackle the question of the infinitesimal in Grasshopper from a mathematical point of view, it would seem at first glance that, by turning the sequencing of the algorithm into a visual node, an amplifier of degrees of intensity enabled by the sliders shifts us to the realm of the infinitesimal, allowing for the seriality to be stretched theoretically ad infinitum. Therefore, paradoxically, sliders that appear to be offering maximum extension, infinite seriality, in fact operate within a finite confined space not only in the sense that the operator is bound by the hidden functions, but also in that every slider operates within a strict range of variables determined by the designer. Paradoxically also, despite the reintroduction of the geometrical relation that defined the Leibnizian differential calculus, unlike the Leibnizian calculus, it is not the geometric relations that manipulate the curve but rather the reverse: it is the curve (the representation of the function) that controls the form.[173] The slider embodies this illusion because it establishes an immediate connection between mathematics, computation, data and time. Therefore, what the sliders pronounce is not the relations between viewpoints, between points of individuation, but rather a formal totality, which is limited to the parameters that encapsulate it and, as such, it is the ultimate site of control. This, I argue, leads to its final immersion in the *Image of Thought*.
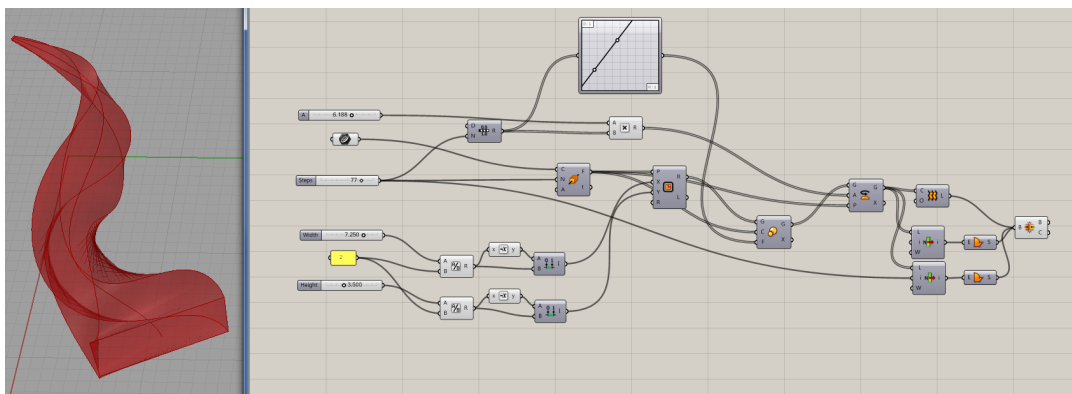
Figure 31: Formal manipulation via graph control

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[173] A similar formal manipulation that is possible away from operating consciously in the realm of data is demonstrated in images 31–34, through a manipulation of a graph that impact the curvature on the screen.
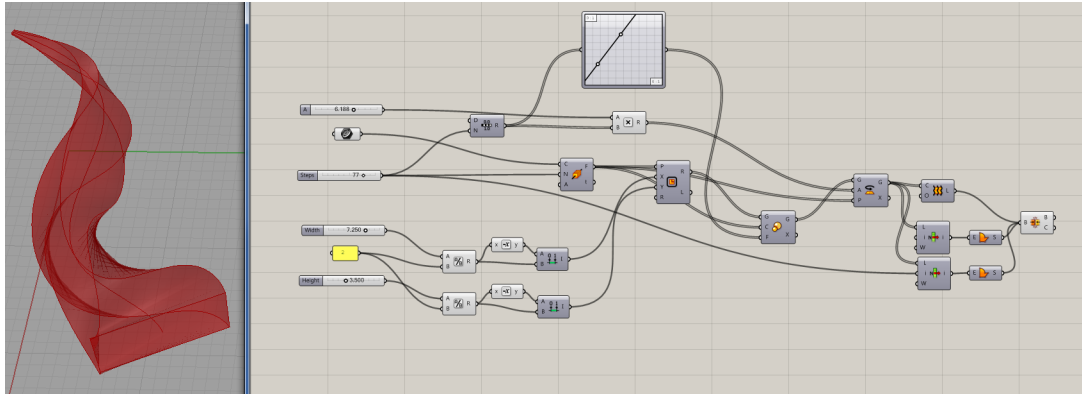
Figure 32: Formal manipulation via graph control
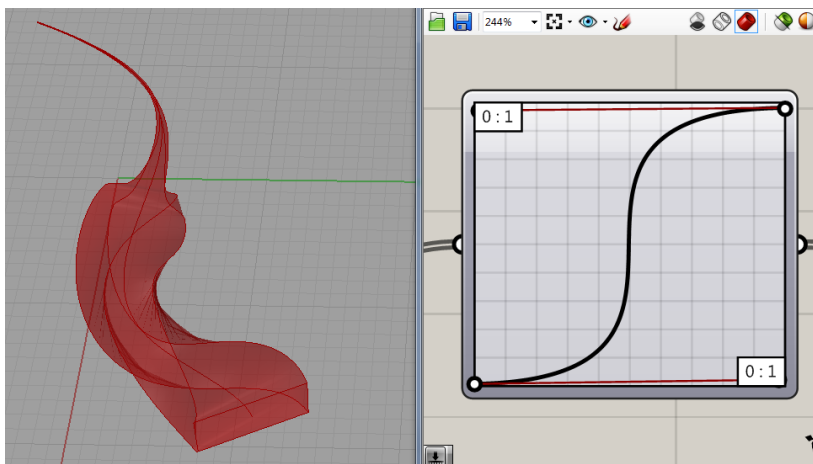
Figure 33: Formal manipulation via graph control
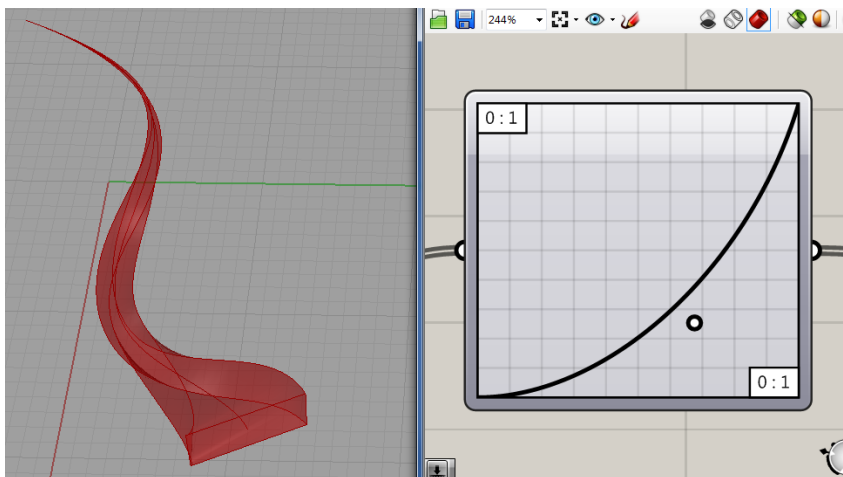
Figure 34: Formal manipulation via graph control

Therefore, I conclude that the practical shift to *Grasshopper* enables a new generation of digital production, which enhances the trajectories introduced by the first generation. The shift to infinitesimal parametric functions that was introduced by Robinson as the mathematical engine to *Grasshopper* impacts the so-called *immanence* directing the production of digital architecture, framed by Schumacher as *Autopoiesis* (Schumacher 2011). Basing digital practice on axiomatic mathematical functions undoes the relational processes of Leibnizian *derivation.* This shift from deriving singularities to a digital use of sliders resolves the tension I referred to in the first chapter; that between post-humanist aspiration of the first generation and their adoption of Deleuze's ontology and on the other end, their focus on formal *continuity.* Grasshopper resolves the tension by perfecting an act of lobotomy created between the screen – the interface and the axiomatic mathematical layer that underpins it. This process further disembodies the architectural processes. Amplified with the complete shift from the realm of geometry (still very much in use in the first generation of digital architecture with its historical reliance on projections and proportions) to the realm of data, which enables a complete abstraction of embodiment.[174]

Transposition: the infinitesimal as nonunitary embodiment

So far I have discussed the process of the mutation of the calculus into digital architecture's mechanism in a way that undoes the infinitesimal and therefore the non-dialectic and post-humanist heritage. This thesis proposes another layer of discussion, according to which, this flow or mutation is not one-sided. Inspired by Braidotti's transversal genealogies, this state of the discourse allows for counter action – that is, from the humanist to the post-humanist.

The infinitesimal is no longer able to articulate itself in current mathematics, claims Deleuze, as he moves to channel the articulation of a differentiated space through the deployment of multiplicity in the creation of nomadic system of relationality. This closing section looks to Leibniz's heritage, that of the

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[174] See Cartography 1, Narrative 1.

embodied, relational, affective mode of differentiation and attempts at its transposition into nomadic feminist discourse, as means of resistance to the rationalist and abstract rule of technology by the reintroduction of politics of embodied location, which I argue is also the legacy of Leibniz infinitesimal. From this point of view, this closing section deals with transposing Leibniz's infinitesimal as part of nomadology. Can we bypass the current iteration of the calculus as the operator of a universal and static world, which does not differentiate and rather maintain the ontology of the infinitesimal in other means? Can the infinitesimal-ontological mode of relationality still be valid, since monadology is dissolved? What did Deleuze mean by his assertion as he concludes *The Fold* that we are all still Leibnizian and that we should find new ways of folding, unfolding and refolding? How does nomadology help Deleuze's folding/ refolding/ unfolding? What is the correspondence between Deleuze's *nomad* and Braidotti's *nomadic theory*?

The nomadic, I show in chapter 1, has a dual genealogy: a Deleuzian nomadic, which is defined by a non-dualist movement to undo Western reliance on central models of cognition, which replaces unity with multiplicity. To Deleuze's definition of the nomadic I add Braidotti's which takes up Deleuze's emphasis on non-dualist mechanisms and supplements it with an embodied accent coming from feminist critical theory. Braidotti injects multiplicity with grounding and positioning movements, with the political and the social, with the actual, but nevertheless, while maintaining the immanence of Deleuze's philosophy by insisting on the nonunitary articulation of such subjectivity.

In *Patterns of Dissonance* (1991) Braidotti ties these two aspects of nomadism together as she reflects on Deleuze's heritage and evaluates the importance of multiplicity to Deleuze to assert a non-dualist reconceptualization of thought. The 'Multiple' therefore is an expression of the 'abolition of the dialectic of negation, in favour of multiple, nomadic thought' (Braidotti 1991, 111).

> 'Multiple' does not mean the dispersal of forces in a given field, but rather, a redefinition of the embodied subject in terms of desire and affectivity, situated in the element of speed, that is to say, time. The multiple is whatever is not attached to any principle of identity and unity, anything

> that knows how to put into play the differences that constitute the affirmative powers of the bodily subject and, through a game of differences, produces meaning. The multiple is what expresses difference in its eternal becoming in its multiplicity of meaning (ibid.).

> In accordance with this multiplicity which is a sign of the positive and non-individual value of every utterance, Deleuze proposes a new role for subjectivity. He formulates it as a new form of impersonality, a new materialism (ibid., 112).

It is multiplicity that influences Deleuze's notion of 'nomadic thought', claims Braidotti, 'which is in fact, literally, an inversion of Leibniz's "monadology"' (ibid., 111).

> Deleuze subverts this vision of one, steady central point of reference, a normative principle of rationality as the privileged viewpoint, seeing without being seen, as in Foucault's notion of the Panoptic. He severs the thread which links the puppets to the master and lets them circulate freely in space, that is to say no longer activated by a central power but through the multiple effects if attraction and repulsion of spatial entities, bodies intersecting with each other [...] (ibid.).

Is the nomad 'an inversion' of the monad as Braidotti suggests? Braidotti's description of the world Deleuze leaves behind – that of the monad – is empty from the traits that drew Deleuze to Leibniz in the first place, with all its imperfections and its inability to contain our own world. Braidotti, who omits any mathematical reference to these two worldviews, the nomad (through the mathematical understanding of multiplicity) or the monad (through the infinitesimal calculus), fails to render the latter in the complexity that characterizes Deleuze's attraction to Leibniz as a reference, precedence to past reconceptualisation of reason. Yes, Leibniz's monad being panoptical is an accurate analysis, for it did allow for a limited perceptive apparatus, a single and hidden angle – but I contest Braidotti's implication that it should necessarily be seen as a mechanism of control. We can approach this move by Leibniz, to obscure the opening so as not to allow a direct gaze as an attempt to free up the monad from the chains of vision, and to enable precisely the affectual relations necessary for the derivation of a point of view. That is to say, by obscuring vision, Leibniz opened up the monad to minute perceptions, to the imperceptible, and

what is more, these minute perceptions then furnish an individuation/ a point of view/ a perspective, (I expand on this mechanism of derivation shortly).

As to the puppets linked to the master metaphor, again, what Braidotti fails to account for is that the monad and the outside world cannot be separated and this is where Leibniz's contribution to Deleuze's thought lies. That is to say that the monad already contains the world and that the process of differentiation of one monad from the next is a process of derivation, which is in effect a process of becoming. The becoming of each monad is a derivative of the different physicality of each monad and the affects that each monad responds to by way of a differential relationship. The thread is not predetermined by a master, by rather is in a constant process of becoming. In fact, I would claim that Leibniz's understanding of what constitutes subjectivity is not far removed from Braidotti's own conception of the nomadic register that characterizes the nonunitary, which entails dissolving the thinking subject into the elements which compose him/ her, 'affective, not rational, *pathos,* not *logos*' (ibid., 112). These elements are all present in Leibniz's process of derivation of a point of view, which is a process of asserting subjectivity as means to defy universalism. Deleuze reminds us that '[Leibniz] has to remain fixed on the singularity, on the individual as such [...] since he forbade himself from invoking universal spirit/ mind in which the world will be included' (Deleuze, Vincennes session, Liebniz Seminar 15 April 1980, 90).

A point of view, which is the basis for perspectivism, allows for a determination of subjectivity. In other words, point of view pre-exists the subject: 'every point of view is a point of view on variation. The point of view is not what varies with the subject, at least in the first instance; it is, to the contrary, the condition in which an eventual subject apprehends a variation [...] or something [...]' (Deleuze 2006 [1988], 21). Furthermore, Leibniz identifies this subjectivity or modus vivendi with a *body*, as the element that comes into differential relationship.

> And finally, Leibniz's stroke of genius: what is it that will define the clear and distinct zone of expression that I have? I express the totality of the world, but I only express clearly and distinctly a reduced portion of it, a

finite portion. What I express clearly and distinctly, Leibniz tells us, *is what relates to my body [...] I express clearly and distinctly what affects my body* (Deleuze, Vincennes Session, Leibniz Seminar 22 April 1980, 95, my emphasis).

Now we come to the modes of perception that allow for a relation of differentiation to take place. The totality of the world is in the individual, explains Deleuze, but in the form of small perceptions, small perceptions without consciousness, which are like differentials of consciousness. Conscious perception is termed *apperception* by Leibniz.[175] Our conscious perception has the capacity to process totalities only; it is the unconscious perception, termed by Leibniz as *minute perceptions*, that we do not perceive, which under a certain condition of disorganization –

> force open the door of my consciousness and invade me. When my consciousness relaxes, I am thus invaded by minute perceptions that do not become for all that conscious perceptions [...] I don't represent them, I do not perceive them, but they are there, they swarm in these cases (Deleuze, Vincennes Session, Leibniz Seminar 29 April 1980).

These minute perceptions are infinite; conscious perception is derived from minute perceptions, not composed of, but *derived* from, there being a relation of differentiation between the two, *between our body and the environment that is when a moment of clarity appears,* or for a body to differentiate, to create a perspective. In order for the particles to be appreciated (Leibniz gives the example of a drop of water singled out of the totality of a wave), a *minute perception* is required, which is an unconscious perception. 'Leibniz tells us: "We must consider that we think a quantity of things all at once. But we pay attention only to thoughts that are the most distinct [...]" For what is "remarkable" must be composed of parts that are not remarkable' (ibid., original emphasis). What is the mechanism in operation?

> I reach a neighborhood of a remarkable point, so I do not operate a totalization, but rather a singularization. It is when the singular point, a remarkable point, that perception becomes conscious [...] perception becomes conscious when the differential relation corresponds to a singularity, that is change in sign (ibid.).

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[175] See Deleuze, *Vincennes Session, Leibniz Seminar* 15 April 1980, 94.

Deleuze goes on to make a point about the type of relations between our bodies and matter:

> It's no longer a relation of parts at all, *it's relation of derivation*. It's the differential relation between that which excites and my biological body that is going to permit the definition of the singularity's neighbourhood (ibid., my emphasis).

Thus, mathematically, the inversion of the sign on a curve, from + to - is the inversion between conscious and unconscious state of perception. This subjectivity is in constant process of becoming and morphing in relation to its capacity to be affected, it does it though in linearity, that is to say, one differentiation at a time, unfolding a single curve. The infinitesimal aspect of the theory stems from Leibniz's assertion that each monad expresses the totality of the world, which is infinite, each expresses it while encompassing a different point of view: 'the proportion of the region of the world expressed clearly and distinctly by an individual in relation to the totality of the world expressed obscurely and confusedly' (Deleuze, Vincennes Session, Leibniz Seminar 22 April 1980, 94). It is this appreciation of the differential calculus as that from which derives subjectivity (which can be equated with nomadic subjectivity), or singularity, which differs from the understanding of the differential calculus as that which produces continuity, a false understanding that proliferates in our digital discourse.

We can conclude that the correspondence between monad and nomad therefore is not one of inversion (as suggested above by Braidotti), but rather is that of derivation. Instead of a return to a dualist/ binary model suggesting the one or the other, my cartography suggests a process of unfolding, unfolding the nomad. This process of derivation entails different perceptions (embedded in our current world) and a different perceptual mechanism (multiple, horizontal) but not necessarily a different perceptual principle which is still affective, embodied and embedded in a multiple– a multiple field of articulation introduced by Riemann and Poincaré. However, Deleuze is disenchanted with the latest developments in mathematics, especially with non-standard that claim to vindicate the infinitesimal in the calculus, which ontologically produces a

universal solution. The impact of this universal solution is in robbing the calculus from deriving a point of view. Hence the possibility of novelty or difference along this route is currently blocked mathematically. Where can we proceed to now if we are to follow on from Leibniz, if our aim is the enactment of differentiated practice, if we would like to inhabit a *point of view*, a transient one? The discussion to follow further unfolds these questions through another model of relationality that informs digital architecture production – biodigital emergence.

Cartography (2) – Digital Practices and Methodologies

Part 2 – Rethinking Biodigital Practices – from Genetic to *Umwelt*

Introduction

Framing digital architecture production with biomimetic processes was already part of the digital experiments of the 90s; nevertheless, these alternative digital investigations were excluded from the main digital narrative. While the formal, Deleuzian-oriented narrative is still digital architecture's official narrative of inception; biodigital architecture is now an established branch of digital production. This practice gained its first acknowledgement in 2004, with the publication of the first issue of *Architectural Design* (AD) to be dedicated to biodigital practice: *Emergence: Morphogenetic Design Strategies*, guest-edited by Michael Hensel, Achim Menges and Michael Weinstock, showcasing their research unit at the *Architectural Association School of Architecture*, London.

In the first chapter, I showed how early biodigital biomimetic experiments were driven by similar attempts to challenge humanist architectural methodologies as those informing the 'official' topologically driven experiments captured in *Folding in Architecture* (1993). In 2004, the main biodigital novelty narrative is framed by a concept of *emergence* of material processes that direct morphogenesis. This biomimetic process, or emergence is enabled with the introduction of genetic algorithms (GAs) to the digital architectural process, which mimics evolutionary processes.

As with *folding,* this *morphogenesis* is a hybrid of post-humanist methodologies and humanist ontologies. The post-humanist methodologies are framed by complexity theories stemming from the computation of evolutionary processes, which, as I unfold shortly, relies on a humanist deterministic interpretation of evolutionary processes, while the ontology framing these processes is rationalist, positivist and universalist. Such a rationalist-positivist and humanist approach to

evolutionary processes and to the capacity of mathematics and computation to translate these processes into architecture methodologies and the architectural aspiration to emulate life processes are developed side by side with post-humanist methodologies based on non-dualistic approach to differentiation process of organisms, human and non-human. As in the previous chapter, this cartography untangles the two worldviews.

Therefore, the first part addresses two distinct methodologies towards the production of biodigital architecture, both of which can be identified as non-representational: a GA-based methodology and, secondly, biodigital processes, which began with morphogenesis in the mid-2000s and changes its focus to the computation of organic matter, while mimicking materialist processes at the molecular resolution. The chapter's structure follows these distinct processes, being constructed in two parts to address the difference in methodologies and the assumptions under which they operate.

The second part delves into the digital premise that enables this current distinct digital production, which goes back to the 60s and 70s – to the development of genetic algorithms by John Holland (*Adaptation in Natural and Artificial Systems* 1975). This is a detailed account of the biological and evolutionary thinking that underpins their development and later computation, and the technical principles these algorithms follow. In particular, this section focuses on the reliance this algorithm manifest on fitness factor and performance based differentiation process, an outcome of a reductive understanding of the evolutionary process. Couples with *emergence* as the main narrative for growth and differentiation, coming from complex theory and describe autopoietic qualities of growth, that which is directed away from an architect control and is driven by inner processes conflates two contradicting ontologies.

 The third part of this cartography introduces alternative concepts to these reductive ontologies that stem from current biological research as well as from turn of the last century ethological research – both leading towards an expansion of the instrumental and universal approach described above to include an active, dynamic and excessive understanding of an organism, taken up by Deleuze and

Guattari mainly in *A Thousand Plateaus.* In addition, I draw on Keith Ansell-Pearson's *Germinal Life, The Difference and Repetition of Deleuze* (1999), which is a reworking of Deleuze's engagement with positivism and determinism in the context of evolutionary processes, provides a cross section or a comparative literature, with and without Guattari, of Deleuze's relation to evolution, complexity and multiplicity as possible producers of difference. Ansell-Pearson reminds us that Deleuze (and Guattari) do not mean to annul the importance of selection, but rather, 'they wish at the same time to emphasize the importance of novel becomings which considerably alter the character of these pressures' (Ansell-Pearson 1999, 178). To this end, Deleuze and Guattari articulate an alternative conceptualization of life that extends beyond critique and into creative realms of thought as means to expand on the Darwinian and neo-Darwinian concepts of evolution – that is theories that emphasis external forces shaping a passive organism, on the grounds that these theories deprive matter of its vitalism, its germinal dynamics. Deleuze replaces these theories of evolution with a project of rethinking life and extracting it from the finitude of positivist thinking as captured and mimicked by science towards lines of flight that suggest creative evolution, which he framed as an *ethical project.*[176] Keith Ansell-Pearson stresses this approach as an ethical stand as he quotes Deleuze: 'Ethics concerns the production of new creative lines of life that depend on how one folds the forces, producing not a new subject but a "work of art"' (ibid., 97).

This project is shared by Elizabeth Grosz, who in *Becoming Undone: Darwinian Reflections on Life, Politics, And Art* (2011), a reworking of Darwin through Deleuze, turn to re-evaluate the notion of *umwelt,* a term arising from the scholarship of the nineteenth-twentieth-century ethologist, Jakob von Uexküll, as emphasizing a receptive organism as part of intricate ecosystem. This re-evaluation in particular brings to the fore the importance of an embodied and embedded understanding of any organism (human/ non-human) as theorizing autopoietic processes as well as being part of an ecosystem. This part of the cartography shifts from a focus on the former, as it moves to account for a respective shift in Deleuze and Guattari's focus, which I refer to here in terms of

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[176] Keith Ansell-Pearson, *Germinal Life: The difference and repetition of Deleuze* (London: Routledge, 1999), 96–7.

the shift rendered in the previous chapter – from monad to nomad – a shift towards multiplicity – which, in the context of this cartography, I frame with the *machinic phylum.* This is to say that the two terms – monad and *umwelt* – share a theoretical bearing and both inhabit Deleuze's thought.[177] Articulating an *umwelt,* I stress in the closing part of this cartography, is still relevant and necessary aspect in our move to biologically informed, molecular-based research in digital architecture as that which embeds and embody biodigital processes, otherwise turning to the universal and deterministic.

This branch of digital discourse is less prominent in the literature of architectural history and theory. This lack of comprehensive theoretical and historical writing dedicated to this field of architectural production, was noted by the architects and educators Achim Menges and Sean Ahlquist, as they write in an introduction to a current compilation, entitled *Computational Design Thinking* (2011),

> We found, however, that no book covered this spectrum of topics in this specific context. This became even more apparent to us when we were in the fortunate situation of acquiring and viewing hundreds of related titles for the library of our newly founded institute for Computational Design at Stuttgart University, while at the same time building up the educational curriculum. Based on the realization that the seminal texts, from which a conceptual model for critical computational design thinking in architecture may originate, are scattered across a vast body of literature, we attempted to collect, filter out and selectively sample the most influential pieces by authors that have either provided a foundation to which a computational approach to design could be pursued or have played a considerable role in shaping the field (Ahlquist and Menges, 2011).

In the limited occasions where literature is available, the attempts to conceptualize this site of digital discourse tend towards the non-critical – for example, *Naturalizing Architecture ('Naturaliser l'architecture')*, a 2013 ArchiLab exhibition, hosted at the FRAC institute, Orléans, curated by Frédéric Migayrou in

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[177] On this point I refer to; Undine Selbach and Stephen Loo, "Insects and Other Minute Perceptions in the Baroque House," in *Deleuze and the Non/ Human,* eds. Jon Roffe et al. (Hampshire: Palgrave Macmillan, 2015), 103–121.

collaboration with Marie-Ange Brayer (Director of FRAC Centre),[178] which set out to establish biodigital architecture as the new narrative of digital architecture as a whole. Their approach conflates topological and biodigital methodologies to one discursive mass. The approach in the publication accompanying the exhibition lacks a critical distance from the discipline, and marvels at and enthuses over the prospect of mimicking of life, framed as a 'biodigital turn' in architecture.

> The implementation of generative protocols, notably founded on the use of cellular automata, genetic algorithms and organic simulation techniques, is opening up unprecedented fields of investigation. Thanks to sophisticated mathematical mastery, architecture is now happening at the level of matter and tends towards the complete recreation of organic matter, made possible thanks to science (Brayer and Migayrou 2013, 10).

This is but one example of a general approach shared by the practices exhibiting in this event and beyond.[179]

Figure 35 (Left): ArchiLab: Naturalizing Architecture 2013/14, official leaflet
Figure 36 (right): ArchiLab: Naturalizing Architecture, Marie-Ange Brayer and Frédéric Migayrou, 2013, book cover image

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[178] The FRAC (Contemporary Art Collection) centre was established in 1999 by Frédéric Migayrou to host a permanent collection of digital architecture. ArchiLab is the centre's international platform/ event/ exhibition/ symposium for the exhibition and discussion of digital architecture, curated sporadically by Marie-Ange Brayer, Director of FRAC Centre. *Naturalizing Architecture* was the 9th ArchiLab exhibition.

[179] For example, the publication contains a text by Graham Harman entitled "Objects and Architecture", discussing his *object-oriented philosophy* as an alternative to Patrik Schumacher's *parametricism*. See Graham Harman, "Objects and Architecture", in *Naturalizing Architecture,* eds. Marie-Ange Brayer and Frédéric Migayrou (Orléans: HYX, 2013), 234–43.

Another discursive platform is professional reference literature – for example, the numerous *Architectural Design* magazine issues, dedicated to biodigital architecture over the past decade.[180] Yet another discursive outlet is biodigital monographs. It is interesting to note a decade's gap between biodigital initial experiments and the written publications (Michael Hensel, Achim Menges and Michael Weinstock 2010, Michael Weinstock 2010).

Figure 37 (left): Michael Hensel, Achim Menges and Michael Weinstock, Emergent Technologies and Design, 2010, Book cover image
Figure 38 (right): Architectural Design, Techniques and Technologies in Architectural Design, Morphogenetic Design, guest-edited by Michael Hensel, Achim Menges and Michael Winestock, 2006, publication cover image

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[180] A partial list of *Architectural Design* issues dedicated to biodigital architecture: *Emergence: Morphogenetic Design Strategies*, guest-edited by Michael Hensel, Achim Menges and Michael Weinstock (2004); *Techniques and Technologies in Morphogenetic Design*, guest-edited by Michael Hensel, Achim Menges and Michael Weinstock (2006); *Protoarchitecture: Analogue and Digital Hybrids,* guest-edited by Bob Sheil (2008); *Neoplasmatic Design*, guest-edited by Marcos Cruz and Steve Pike (2008); *Material Computation,* guest-edited by Achim Menges (2012); *Material Synthesis: Fusing the Physical and the Computational*, guest-edited by Achim Menges (2015).

Biodigital narratives

Biodigital practice posits itself as an alternative to topological/ parametric digital architecture production, claiming to be operating 'real complexity' missing from the topological/ parametric discourse. The narrative suggested by architects such as Roland Snooks and Achim Menges posits morphogenetic methodologies practised by biodigital architecture as complex procedures that overturn formal and representational practices. Achim Menges suggests biodigital *emergence* practices as an alternative to the humanist architecture procedures developed by Alberti with their reliance on representational tools – 'elaborating of form over its subsequent materialisation' (Menges 2010, 44) – suggesting instead a reliance on the materialist tradition in architecture that goes back to Antoni Gaudi and Frei Otto. Menges critiques the digital design discourse as 'still mainly employed to create design schemes through a range of design criteria that leave the inherent morphological and performative capacities of the employed material systems largely unconsidered'. As an alternative, Menges puts forward a decade-long research project conducted at the AA: a 'morphogenetic approach to design that unfolds morphological complexity and performative capacity from material constituents without differentiating between formation and materialisation process' (ibid.). I explore these new materialist claims to the production of architecture, as I question the effectiveness of such an alternative to better differentiate, or to account for qualitative difference, while still operating within humanist, positivist and universalist ontologies.

The architect Roland Snooks shares this view on the limitation of topological led digital architecture to enable qualitative difference. His criticism is directed at parametricism's tendency towards homogeneity, which he counters specifically by genetic algorithms as an alternative design protocol. His critique of parametricism is inadvertently a critique of a humanist, predetermined and finite parametric practice:

> The parameters within these [parametric] models – as the now ubiquitous sliders in software programs epitomize – confine the model to a known set of limits. So while parametric models enable a distribution of

difference, this is not the difference that emerges from intensive processes, but rather as directly described, top-down, smooth gradient operating within a predefined range. Here all possibilities are already given within the starting condition […] These strategies presuppose that architecture can be objectively evaluated through predetermined criteria, which is effectively a straightjacket to speculative design. Optimization rejects subjective evaluation in favour of a reductive approach (Snooks 2012, 56–7).

Snooks counters this protocol with John Holland's genetic algorithm on the premise that such methodology is capable of 'volatile evolution' (ibid.). While I share his reservations about parametricism and its capacity to promote difference, as I have argued in the previous cartography, I nevertheless question the endorsement of genetic algorithms as a means of differentiation.

This chapter problematizes this claim by showing genetic algorithms as rising from a positivist and deterministic lineage, which exposes the field to the same unaccounted-for hybridity I referred to in the previous cartographies.

The expansion of architectural education and production over the past decade to incorporate science labs in the fields of molecular biology and genetic bioengineering along with their methodologies, such as at the *Architectural Association*, London; the *ESARQ*, Barcelona; the *Bartlett,* London; *MIT* and others, incorporating disciplines that operate complex, non-dualist models, has continued to operate within deterministic ontologies that stem from a restricted neo-Darwinian understanding of what the evolutionary process may entail. Further, the simplistic way in which they were translated via computation to algorithms is deterministic. In other words, the process entails both positivism in relation to the overall ambition and belief in science to mimic the biological as well as a deterministic and totalizing application of finite models as a means of differentiation.

This conflated, and by now prevalent, stand of biodigital architecture has emerged because of the persistent deterministic perception of the role of science that speaks to binary, linearity and fixed categories framing complexity theories that underlie biodigital methods. This hybrid fuels our current digital era of

'wonder'.[181] Rather than colonized bodies that the industrial age of wonder was fuelled by, it is the micro process that enable these bodies that are being colonized today.[182] This powerful hybrid emerges from an unquestionable shift in the role of architecture from a metaphorical creation to aspirations towards a complete recreation of organic matter.[183] This is made possible by a simplified formula, which implies a natural conversion, according to which biological processes can be merely translated into the creation of all matter via mathematical mastery. Moreover, I argue that the same positivist wonder channelling the complexity of life underlies the development of GAs. The architectural historian and critic Christina Cogdell has described GAs in terms of 'eugenic processes',[184] which suggests an active strategy of selection and weeding on the basis of a set of finite criteria. This critical approach is not shared by biodigital architectural discourse, where terminology such as *Breeding Architecture* is freely in use.[185]

In continuing cartographic attempts of the discourse, this part adds to the above general critique an embodied and embedded analysis which begins with the computational sub-layer that is the meeting point of humanist, reductive ontologies with complex and emergence tools – that of the genetic algorithm itself.

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[181] This is a reference to Alisa Andrasek's Bartlett *WonderLab*. Wonder, I argue, not only signals a reference to a positivist era, that of the nineteenth century that is identified by an unproblematized gaze on nature. *Wonder* used as a noun, as in the case of Andrasek, denotes admiring passivity, which is not the case if wonder is used as a verb, in which case it is an active, curious and questioning state. Andrasek musing on *'A new generation of artists writing genomes as fluently as Blake and Byron wrote verses, might create an abundance of new flowers and fruit and trees and birds to enrich the ecology of our planet. Most of these artists would be amateurs, but they would be in close touch with science, like the poets of the earlier Age of Wonder.'* Freeman John Dyson, referencing *The Age of Wonder* by Richard Holmes, (https://www.bartlett.ucl.ac.uk/architecture/programmes/postgraduate/labs/march-architectural-design/wonderlab).

[182] This analysis is shared by critical theorists of advanced capitalism; examples are Braidotti, Preciado, Massumi and Clough. I return to this point in chapter 3.

[183] See for example Alberto Estévez's practice below.

[184] See Christina Cogdell, "Breeding Ideology: Parametricism and biological architecture", in Matthew Poole et al., ed., *The Politics of Parametricism: Digital Technologies in Architecture* (London: Bloomsbury, 2015), 123–137.

[185] For example, see Manuel DeLanda, "Deleuze and the use of the Genetic Algorithm in Architecture", *Architectural Design* 71(2002): 9.

Genetic algorithm (GA)-inspired digital design

This account traces the inherent assumption over questions of evolution endorsed by digital architects (mostly inadvertently) and what they entail in relation to the understanding of life and the body, which they promote through the use of biomimetic processes by investigating the use of GAs in digital architecture. I commence by recounting the history of GAs and their introduction to digital architecture practice. I look into the main assumptions and operational models at the basis of these algorithms in order to locate the processes introduced to architecture. These practices are traced back to the 1970s, to the development of GAs as a problem-solving mechanism by John Holland. This cartography show that biomimicry processes are derived from a deterministic interpretation of evolutionary processes, emphasizing selection through *fitness factor* embedded in the computational and biological thinking behind the development of GAs, which is a predominantly deterministic and finite, not to mention hierarchical aspect of their formation and operation, under a guise of material complexity.

I look into the thinking and production that renders these assumptions of 'growing architecture' in two architectural educational hubs: ESARQ, Barcelona and the Bartlett, London, where specialist architecture programs have been established with the specific aim of teaching and researching biological models for the production of digital architecture. I then go on to discuss the work of Emtech at the *Architectural Association*, London, where GAs are put to use under an *emergence* narrative.

Writing in matter

In the second part of this cartography I move on to discuss in detail the work of Achim Menges and his group at the University of Stuttgart.[186] Over the past

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[186] 'Professor Achim Menges, born 1975, is a registered architect in Frankfurt and professor at the University of Stuttgart, where he is the founding director of the Institute for Computational Design since 2008. He also is Visiting Professor in Architecture at Harvard University's Graduate School of Design since 2009. He graduated with honors from the AA School of Architecture in London where he subsequently taught as Studio Master of the Emergent Technologies and Design Graduate Program from 2002 to 2009, as visiting professor from 2009 to 2012 and as Unit Master of Diploma Unit 4 from 2003 to 2006. From 2005 to 2008 he was Professor for Form Generation and Materialization at the HfG Offenbach University for Art and

decade, Menges's work has changed its focus from GA-based research while at the *Architectural Association* (2002–2008) to a sophisticated ambition to code tectonics, marking a shift from coding digitally to coding architecture's materiality itself. This shift is ripe with the potential to actualize a new materialist, nomadic agenda. However, when I follow Menges's recent research, especially as manifested in the ICT/ITKE pavilion series built annually on the University of Stuttgart site, I identify the same hybridity between humanist and post-humanist approaches that I attribute to the formal mathematical strands of digital architecture, past and present. On the one hand, Menges' practice draws upon materialist traditions in architectural research, on past non-representational architectural approaches influenced by the likes of Frei Otto; on the other hand, Menges operates within a humanist ontology on the premise of a disembodied universalist approach to design and a divide between the natural (biological) and the cultural (digital). His approach is therefore contained within the premise of the positivist and colonial 'era of wonder' towards the natural world, as that which lies outside and awaiting discovery; it also disregards an acknowledgement of situating in matter (embodying and embedding) and, as such, is still universal. This ontology hinders the production of a differentiated and nomadic practice.

Moreover, the methodologies practised by Menges implies a belief in clear lines of descent and segregated lines of species. I question the unattainability of such linearity of descent with the introduction of digital tools, not only from the standpoint of the design process, as I argue that the disciplinary divide where the biological and the architectural (the organic and inorganic) is unattainable, and that the humanist approach can no longer adheres to such purity, when otherness is already part of the biological – otherness as predominantly, and beyond, as a fundamental condition of the nomadic, nonunitary post-human condition. I propose to investigate this mutation along the lines of Deleuze and Guattari's *machinic phylum,*[187] as I elaborate on the potential of this undercurrent machinic flow to undo Menges's ordered phyla to contribute to a

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Design in Germany. In addition he has held visiting professorships in Europe and the United States.' As quoted from Menges's CV at the web page of the ICD, http://icd.uni-stuttgart.de/?p=897 (last accessed 12 May, 2016).

[187] Deleuze and Guattari, *A Thousand Plateaus*, 451. See below.

broader, nuanced and differentiated notion of biodigital architecture. I frame the machinic in the context of digital architecture with data, which I develop further in the last chapter.

Growing Biodigital Determinism – from Evolution as Selection

'Growing' digital architecture

The immersion of the discourse in established external models aspiring for complexity has developed to encapsulate a discipline that only a decade ago was debating its autonomy. While past turns to biological inspiration involved mimicking of passive traits, such as formal or organizational biological aspects,[188] current biomimetic methodologies encompass the ambition to mimic the biological processes themselves, enabled by the amalgamation of these architectural processes with methodologies and processes derived from molecular and genetic biology.[189] This turn is well established in the realm of architectural education, where the processes of mimicry have gathered followers, although not exclusively, in three educational hubs: the *Architectural Association,* London; the *ESARQ*, Barcelona; and the *Bartlett*, London. These specialist architecture programmes were established with the specific aim of framing academic research and the teaching of digital architecture with biodigital models. Although each programme operates different methodologies, they all share the ambition to digitally *grow architecture* while using growth algorithms, such as cellular automata, genetic algorithms and agent-based algorithms. I limit this enquiry to the ambition to grow architecture by means of genetic algorithms and to its reliance on neo-Darwinist theories of evolution, which reintroduces biological terms, now obsolete, such as natural selection to

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[188] See for example in the work of D'Arcy Thomson. D'Arcy Thomson, a zoologist and mathematician, who is regarded as a part of a genealogy that attempts to articulate biological forms in mathematical formulae, considering the material forms of living things as diagrams of the forces that have acted on them. (Thomson 2014 [1915]) See *On Growth and Form*, Cambridge University Press, 1961 (first published 1917), still an important reference point in digital architecture circles.

[189] Evolutionary processes captured in genetic algorithms are only one example of a field immersed in mimicking via other computational models, such as cellular automata and agent-based behaviour and the current and most advanced in its mimetic ambition to incorporate molecular thinking methodologies into the architectural materiality.

the evolutionary process by means of a fitness factor to emulate the impact of the environment in the process of selection. This section questions the ambition to grow architecture and the embracing of the belief in the power of mathematics and computation to mimic life.

The evolutionary scientific approach to growth and architecture was introduced by John Frazer at the *Architectural Association* in the early 90s. His work is one of the first examples of incorporating GAs into the architectural design process. His 1995 book, *An Evolutionary Architecture*,[190] is still an influential reference book in digital architecture circles. This experimental approach is now a digital convention, evident in specialized digital architectural programmes that articulate this expansion of architecture along biomimetic lines: for example, two post-graduate programmes, Master's and Ph.D., were developed at the ESARQ, the Architecture School of the Universitat Internacional de Catalunya in Barcelona in 2000 – *Genetic Architectures* and *Biodigital Architecture.*[191] The ambition of its founder, Alberto Estévez, is to grow cities.[192] A manifesto-like polemics can be traced in a publication introducing the framework for these two programmes, as he discusses the break from past biodigital approaches:

> These new lines of investigation do not refer even to the typical metaphors studied in bionics, mechanical forms, and other forms applied by natural devices through imitation or inspiration. This investigation is nothing to do with those already obsolete approaches, especially since our reference is plain reality. In other words, we are addressing an incipient reality, the novelty of which is rooted in the evidence that the seed has just started to germinate and it is the time to begin to look after its development. At this precise moment, discussion must centre on the seed's future in order to prepare for the harvest season (Estevez 2003, 7).

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[190] John Frazer, *An Evolutionary Architecture* (London: Architectural Association, 1995).
[191] See Alberto Estévez's CV: http://www.artyarqdigital.com/fileadmin/user_upload/PDF/Integrantes_Ingles/GRUPO._Integrantes._Alberto._Ingles.pdf (last accessed on 25 March 2016).
[192] 'As a soft and furry city (hairy): a living city. A city that takes every advantage that nature teaches us […]. The city of the future will be of 50% biological technology and of 50% digital technology (100% biodigital). Living houses that grow alone, trees that give light at night, plants that give warmth in winter: a city that seems more a forest than a containers landscape of a port. After all, where we prefer to live, in boxes or in trees? We must end with the city-countryside dichotomy: like a dirty oil stain, our cities are destroying nature wherever they grow. But we must be able to get that every human footprint becomes creator of life.' Ibid.

The ambition here is to grow architecture literally, out of organic matter, where the goal is to find the mechanism to contain the growth and channel it, and therefore the organic materials used, for example, are algae, bacteria and fungi, weaving these materials into the built environment. Such a methodology maintains the de facto separation between the built/ grown realms. For example, a joint venture between the Genetic Architecture research group at the ESARQ, Barcelona, and Alberto Estévez's own architectural practice is the decade-long project called *Genetic Barcelona*, running in phases between 2003 and 2014. The genetic creation of bioluminescent plants for urban and domestic use – lemon trees with genes originally taken from bioluminescent jellyfish with Green Fluorescent Protein (GFP) – marks a different, genetic, process. It is apparent that the biological processes are applied to the organic matter, while the production of what we term architecture is being conducted separately. The design output of such approach is limited to small-scale urban interventions.

A similar approach to biomimicry is shared by BiotA at the Bartlett School of Architecture.[193] The Bartlett was relatively late in dedicating a programme to biodigital architecture research. Marcus Cruz has established BiotA Lab, a biotechnology and architecture lab, as is part of a broader restructuring of the Master's programmes into labs that took place in 2015.[194] These programmes form examples of the above-mentioned shift in digital architecture towards the scientific in general, and towards the biological specifically. In the case of these programmes, the overall approach to mimicry and to biology has continued on the methodological lines of past materialist references in architecture (the frequently mentioned Gaudi and Otto), these can be defined as process where the biological materials are approached separately from the computational, and the computational is limited to structures supporting the organic, or to

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[193] An introduction as quoted from BiotA Lab website: 'The lab explores new modes of simulation and production in architecture, as well as advances in the field of synthetic biology, biotechnology, molecular engineering and material sciences, and how these subjects are leading towards an ever-increasing multidisciplinary approach to environmental design. The result is a new sense of materiality, new hybrid technologies and unprecedented living forms that are redefining not only building design, but our whole built environment.' (http://www.biota-lab.com, last accessed 1 April 2016).

[194] In June 2015, the MArch Architectural Design and MArch Urban Design program that form part of the B-Pro program at the Bartlett, have been rebranded and reorganized as labs: Wonder Lab (Alisa Andrasek), BiotA Lab (Marcus Cruz and Richard Beckett), Interactive Architecture Lab (Ruairi Glynn) and Urban Morphogenesis Lab.

simulation. Such is the case in the examples of the various algae-related structures: Urban Algae Folly by ecoLogicStudio (2015); Alga(e)zebo by marcosandmarjan with Richard Beckett (2014); 'HORTUS.PARIS', part of the Alive exhibition at EDF Foundation in Paris (2013); and Algae Cellunoi by Marcos Cruz and Marjan Colleti with Richard Beckett and Guan Lee, exhibition installation at ARCHILAB 2013 – Naturalizing Architecture, FRAC Centre, Orléans France.[195]

Figure 39: BiotA brochure, Bartlett School of Architecture

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[195] The popularity of these methods is wide spreading. For example, See Synthetic Design Biotopes platform "Syn.De.Bio", last accessed November 2016. http://syndebio.com. For a plethora of algae related projects and practices.
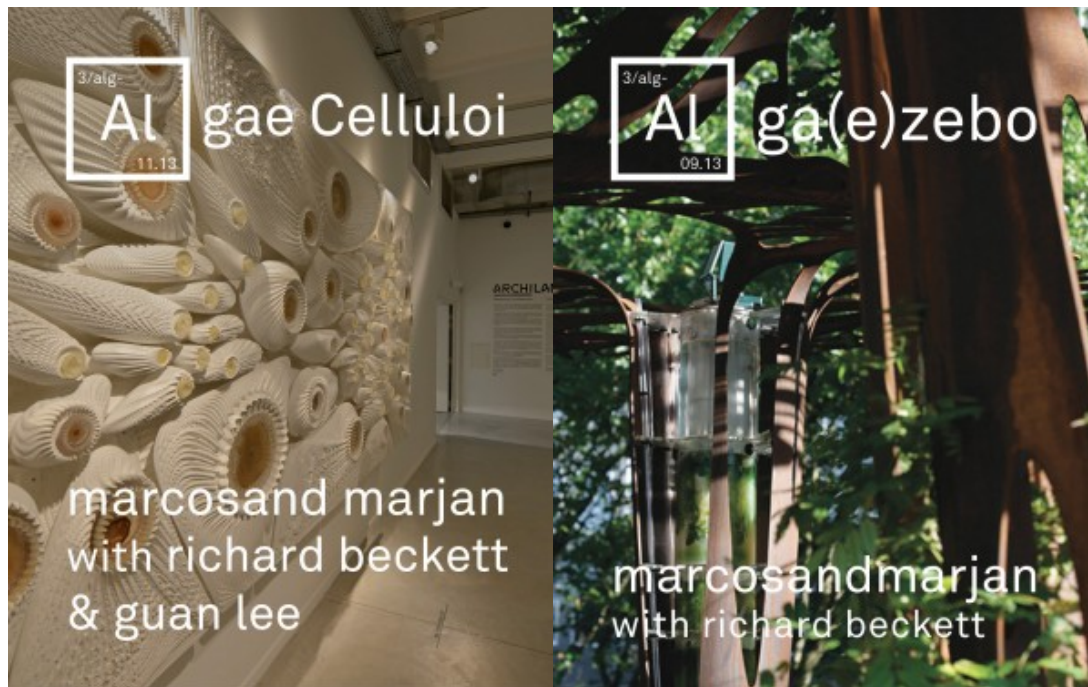
Figure 40 (left): AlgaeCelluloi, by marcosandmarjan at ARCHILAB 2013 – Naturalizing Architecture, FRAC Centre, Orléans France.
Figure 41 (right): Algae(e)zebo, with Richard Beckett, 2014, London
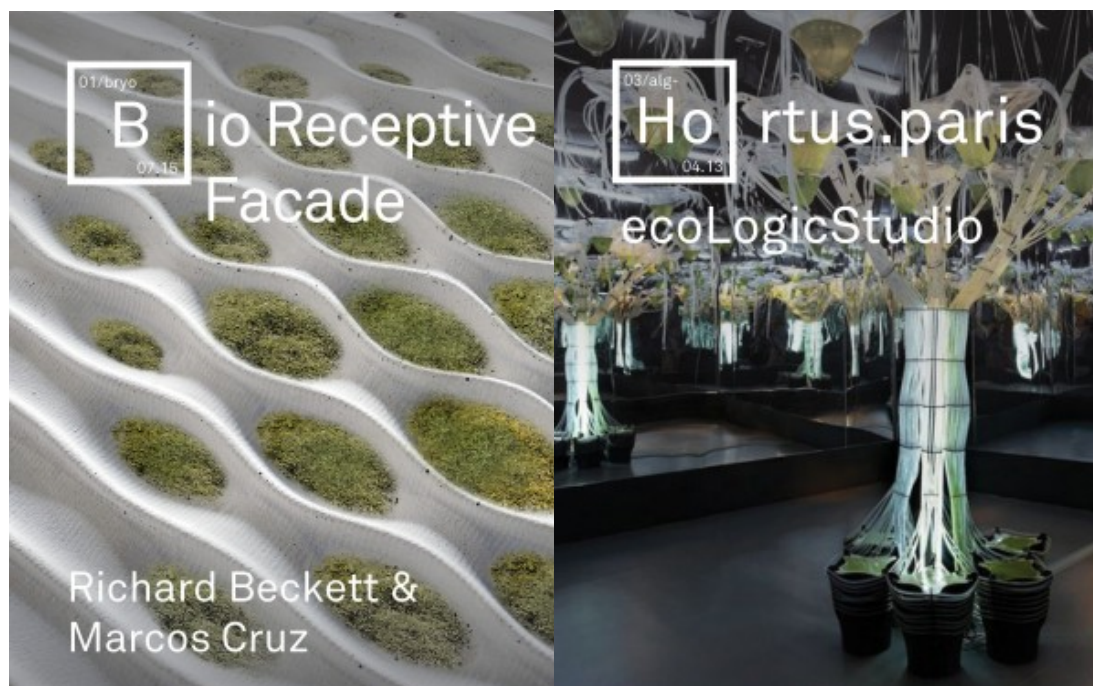
Figure 42 (left): Bio Receptive Façade, by Richard Beckett & Marcos Cruz, 2015, London
Figure 43 (right): Hortus.paris, ecoLogicStudio, 2014, Paris

The third educational hub, founded in 2001 at the *Architectural Association*, is Emergent Technologies in Design programme (Emtech), established by Michael Hensel and Michael Weinstock joined by Achim Menges in 2006. Emtech embodies a re-articulation of the relationship between the bio and the digital in a way that necessitates the rethinking of disciplinary and human boundaries. I now turn to discuss the Emarch project's ambition to emulate evolutionary processes, encoding both materialities, the computational and the tectonic, where the 'natural' is removed from the exclusivity of the biological. Despite this new materialist methodology, the overall ontology remains deterministic and reductionist in its ambition to translate biological processes into the realm of architectural thinking. This points to an engrained positivist approach that celebrates the power of science to channel all complexity and all materiality by simulating life.

It is already in the biological-computational sub-layer that these reductions take place, while I trace the biological evolutionary processes that underlie the construction of GAs. In other words, this cartography points to a double act of positivism framing the ontology of the biodigital process: the first resides in the processes of mimicry, and the second in harnessing these reductionist approaches to evolution into the digital architectural project. This humanist ontology frames a post-humanist methodology, that of *emergence.*

Emergence harnessed/ growing biodigital determinism
Emtech's most ambitious publication, *Emergent Technologies and Design: Towards a Biological Paradigm for Architecture* (2010) opens with an external reference to a definition of their main narrative, *Emergence* by Tom De Wolf and Tom Holvoet (2006):[196]

> A system exhibits emergence when there are coherent emergents
> (property, behavior, structure…) at the macro-level that dynamically arise
> from the interaction between parts at the micro-level. Such emergents are

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[196] The authors refer the reader to T. De Wolf and T. Holvoet (2005), "Emergence versus organization: Different concepts but promising when combined", in *Engineering Self-Organizing systems: methodologies and applications. Lecture notes in Artificial Intelligence*, New York: Springer, 1–15.

novel with regards to the individual parts of the system (Michael Hensel 2010, 12).

Alongside this definition of emergence, the authors provide a definition of a self-organizing system: 'Self-organization is a dynamical and adaptive process where systems acquire and maintain structure themselves without external control' (ibid.)*.* I would like to refer directly to Hensel, Menges and Weinstock's source for the definitions above, because the context for De Wolf and Holvoet's text is missing. It is important to note that De Wolf and Holvoet's scholarship is in computer science. In their original paper, they propose a redefinition of the often intermixed *emergence* and *self-organization*, stressing that these two terms are not synonymous; while in *emergence* the emphasis is on novelty, a macro novel behaviour that emerges as a result of the interaction between the local agents, in the case of *self-organization* the emphasis is on the autonomy of the system, the fact that it operates without external control.

The interesting point to stress in the context of my cartography is the historical background of both these concepts. The concept of *Emergence* has a long history, beginning in the late-nineteenth century, when it was first used as the 'backbone of a loosely joined movement in the sciences, philosophy and theology known as emergent evolutionism or proto-emergentism' (Holvoet n.d., x). A movement founded as a reaction against prevalent scientific reductionist notion, namely, that a system could be reduced to the sum of its parts. A second way by which the term has been used was in the context of 1920s neo-emergence or what is better known as *complexity theory*. Emergence in this context has shifted from the descriptive to the scientific, as phenomena in need of a scientific analysis in the fields of mathematics, cybernetics, evolutionary biology, artificial intelligence, artificial life and so on. In short, the uses of the concept of emergence refer to two important characteristics: a global behaviour that arises from the interactions of the local parts, and that, which cannot be traced, back to the individual parts. Taken out of this diverse context, Hensel, Weinstock and Menges limit their interest in the emergent system to the context of engineering only, while keeping their intellectual road map in common with the typical references in architectural circles' discussion of biomimetic processes and

architecture. This genealogy includes the mathematical logic of evolution and biological development and, on the experimental development of evolutionary algorithms, heredity, genes and their mathematical manifestation, D'Arcy Thompson and Darwin.

The Darwinian model: Evolution as selection

I would like to explore the now common, and untroubled terminology of digital architecture discourse that includes the biomimetic, biodigital and GAs, because these seemingly natural processes are in need of a cartography of their hidden reductive assumption: that a mathematico-computational model can account for the complexity of life, and that by stripping the morphogenesis to the equivalent of genes, one can write, or code, uninterruptedly.

> Computational form-generating processes are based on 'genetic engines' that are derived from the mathematical equivalent of the Darwinian model of evolution and from the biological science of evolutionary development of that combines processes of embryological growth and evolutionary development of the species [...] This approach is part of the contemporary reconfiguration of the understanding of 'nature', a change from metaphor to model, from 'nature' as a source of shapes to be copied to 'nature' as a series of interrelated dynamic processes that can be simulated and adapted for the design and production of architecture (Weinstock 2010, 26–7).

The above quotation opens a discussion of two seemingly trivial concepts: the first is *form-generating* and the second is *genetic engine.* While the first assumption is to be discussed at a later stage, I commence by unfolding the latter. 'Genetic engines', Weinstock explains,

> are derived from the mathematical equivalent of the Darwinian model of evolution, and from the biological science of evolutionary development that combines processes of embryological growth and evolutionary development of the species (ibid., 26).

The authors further elaborate on the Darwinian model:

> In Darwin's view variations are random, small modifications or changes in the organism that occur naturally in reproduction through the generations. Random variation produces the raw material of variant forms, and *natural selection acts as the force that chooses the forms that*

> *survive* […] organisms themselves are changed by natural selection, in a slow, steady, gradual and continues process (ibid., 29, my emphasis).
>
> Genetic information passing down through the generations modifies the forms of living beings and their interaction with their environment and the materials and energy that they extract from it. As each generation succeeds its ancestor's, information is propagated down through time. Changes and modifications to living forms occur both by mutation or 'copy errors', and by the recombination of existing information into new sequences and patterns (ibid., 32).

Although Weinstock notes that Darwin was aware of other forces of change, he nevertheless points to the centrality of natural selection as the differentiation mechanism to Darwin's theory. The evolution of a single organism from an embryo to an adult form was in Darwin's time regarded as related but distinct from the evolutionary 'descent from ancestors'. Weinstock quotes Darwin, and further: 'the early cells or units possess the inherent power, independently of any external agent, of producing new structures wholly different in form, position, and function' (ibid., 29). Weinstock then points to Gould's overturning of Darwin's theory, which was published nearly 100 years later, *Ontogeny and Phylogeny* (1977), claiming that it is 'the changes in timing of the developmental processes relative to each other and to the rate at which they are carried out' (ibid.), that lead to formal changes. Already in 1917, Weinstock explains, D'Arcy Thompson maintained that modifications in the environment would produce formal modifications and that those modifications would be applied through the entire body.[197]

Nevertheless, in the next section I show that in the 'translation' of evolutionary theory to a computational procedure, the two main pillars of Darwinism remained unchanged: first, a genetic code is carried down the generations via a mechanism of selection of the fittest individuals to carry it through, as the only mechanism of differentiation; the second is that any modification to the code is explained by changes to the environment. In other words, the process entails a narrative according to which an active environment modifies a passive organism. Moreover, the articulation of this process is formal, and therefore, a functional

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[197] Weinstock, 30.

level of discussion of an organism is being maintained. In the next section, I go on to explore the make-up of GAs.

Genetic Algorithms – Exploring the Process by which Biomimicry Operates
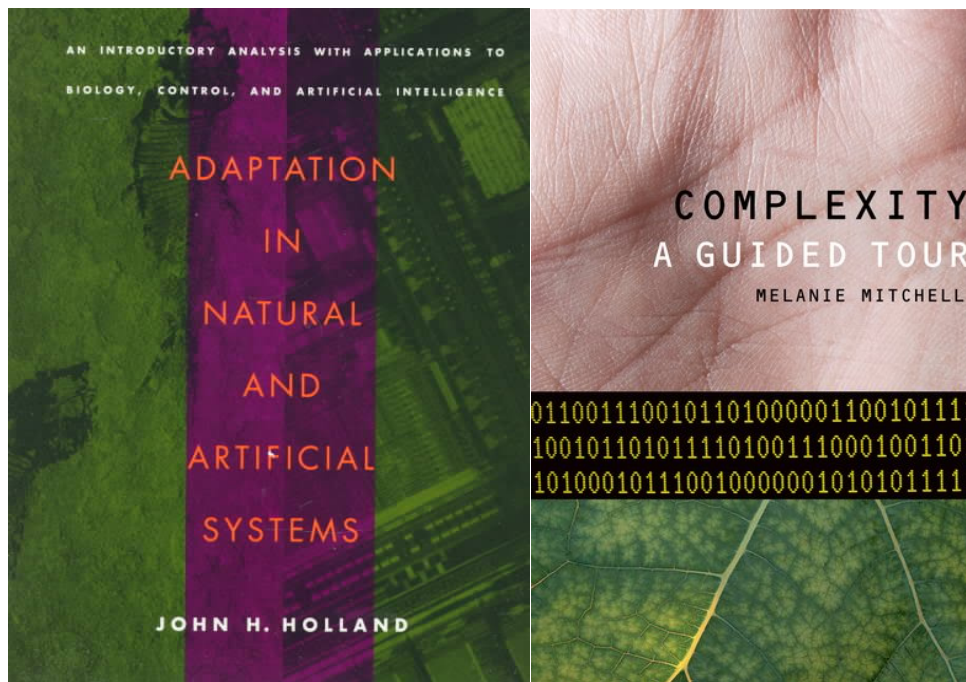
Figure 44 (left): John Holland, Adaptation and artificial systems, 1975, book cover image
Figure 45 (right) Melanie Mitchell, Complexity: A Guided Tour, 2009, book cover image

GAs, the biodigital architecture's *genetic engines,* were developed by John Holland and his group of students and colleagues at the University of Michigan in the 1960s and 1970s.[198] My sources for the work and approaches of this group are Holland's own writings (influential among biodigital architecture students) and the writings of the computer scientist, and Holland's former student, Melanie Mitchell, who has written extensively about complexity theory in computation (*Complexity: A Guided Tour,* 2009) as well as specifically discussing the history and development of GAs (*An Introduction to Genetic Algorithms*, 1996), where she clarifies John Holland's ambition:

> In contrast with evolution strategies and evolutionary programming, Holland's original goal was not to design algorithms to solve specific

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[198] Picking up on the research at the point where Von Neumann had left it.

problems, but rather to formally study the phenomenon of adaptation as it occurs in nature and to develop ways in which the mechanisms of natural adaptation might be imported into computer systems (Mitchell 2001, 2–3).

In his 1975 theoretical book, *Adaptation in Natural and Artificial Systems*, Holland presents GA*s* as 'abstraction of biological evolution' and gives a theoretical framework for adaptation under GAs. The evident connection between GAs and Darwinian evolution are made even clearer by Mitchell as she discloses an autobiographical note about Holland: 'Holland got hooked on Darwinian evolution when he read Ronald Fisher's famous book, *The Genetical Theory of Natural Selection'* and she quotes Holland himself on the topic: 'That's where genetic algorithms came from. I began to wonder if you could breed programmes the way people would say, breed good horses and breed good corn' (Mitchell 2011, 128). It was the phenomenon of *adaptation* that took his interest, articulated as a question of differentiation:

> How living systems evolve or otherwise change in response to other organisms or to a changing environment, and how computer systems might use similar principles for adaptation, including a proposal for genetic algorithms (ibid.).

The traditional theory of GAs (first formulated by Holland 1975) assumes that:

> At a very general level of description, GAs work by discovering, emphasizing, and recombining good 'building blocks' of solutions in a highly parallel fashion. The idea is that good solutions tend to be made up of good building blocks – combinations of bit values that confer higher fitness on the strings in which they are present (Mitchell 2001, 27).

Reflecting on the publication of the first edition (1975) of his book, *Adaptation in Natural and Artificial Systems,* Holland reflects about GAs' widespread application:

> Genetic Algorithms began to be seen as a theoretical tool for investigating the phenomena generated by complex adaptive systems – a collective designation for nonlinear systems defined by the interaction of large numbers of adaptive agents (economies, political systems, ecologies, immune systems, developing embryos, brains, and the like) (Holland 1993 [1975], x).

I would like to stress that the make-up of Holland's GAs' reliance on mimetic evolutionary processes is maintained, regardless of the various mutations GAs have been going through ever since their invention. The biologically infused incentive, as well as components, remains: accordingly, the components of a GA encapsulate their biomimetic lineage:

Chromosomes typically refer to a candidate solution to a problem, often encoded as a bit string.

Genes are either single bits or short blocks of adjacent bits that encode a particular element of the candidate solution.

Allele in a bit string is either 0 or 1; for larger alphabets more alleles are possible at each locus.

Most methods called GAs have at least *populations of chromosomes* in common. The chromosomes in GA population typically take the form of a bit string. Each locus in the chromosome has two possible alleles: 0 and 1. Each chromosome can be thought of as a point in the search space of candidate solutions. And an 'operating system' that includes *Selection*: the operator selects chromosomes in the population for reproduction. The fitter the chromosome, the more times it is likely to be selected to reproduce. *Crossover*: this operator randomly chooses a locus and exchanges the subsequence, a locus before and after that locus between two chromosomes, to create two offspring. For example, the strings 10000100 and 11111111 could be crossed over after the third locus in each to produce the two offspring 10011111 and 11100100. The crossover operator roughly mimics biological recombination between two single-chromosome (haploid) organisms. *Mutation*: this operator randomly flips some of the bits in a chromosome. For example, the string 00000100 might be mutated in its second position to yield 01000100. Mutation can occur at each bit position in a string with some probability, usually very small.[199] In short, Holland's GAs is a method for moving from one population of 'chromosomes' (e.g., strings of ones and zeros, or 'bits') to a new population by using a 'natural selection' process, together with the genetic-inspired operators of crossover, mutation and inversion. Each

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[199] Mitchell, 2001, 10.

chromosome consists of 'genes' (e.g., bits), each gene being an instance of a particular 'allele' (e.g., 0 or 1). This is done according to the following principles:

> The selection operator chooses those chromosomes in the population that will be allowed to reproduce, and on average the fitter chromosomes produce more offspring than the less fit ones. Crossover exchanges subparts of two chromosomes, roughly mimicking biological recombination between two single chromosomes ('haploids') organisms; mutation randomly changes the allele values of some locations in the chromosome, and inversion reverses the order of a contiguous section of the chromosome, thus rearranging the order in which genes are arrayed. (Here, as in most of the GA literature, 'crossover' and 'recombination' will mean the same thing) (Mitchell 2001, 3).

Selection translates to a set of parameters, known as a *fit-factor,* and is therefore a central concept for the application of GAs. Mitchell stresses that:

> The GA most often requires a fitness function that assigns a score (fitness) to each chromosome in the current population. The fitness of a chromosome depends on how well that chromosome solves the problem at hand [...] One common application of GAs is function *optimization* where the goal is to find a set of parameter values that maximize, say, a complex multi parameter function (ibid., 9).

Both fitness and optimization have (re)entered the architectural discussion and production.

Genetic Algorithms: The Reiteration of Sameness in the Work of Emarch, AA

Michael Weinstock recognizes the relevance of the early development of GAs by Holland to the development of architecture models on the following basis:

> Genetic algorithms initiate and maintain a population of computational individuals, each of which has a genotype and a phenotype. Sexual reproduction is simulated by random selection of two individuals to provide 'parents' from which 'offspring' are produced. By using crossover (random allocation of genes from the parents' genotype) and mutation, varied offspring are generated until they fill the population. All parents are discarded, and the process is iterated for as many generations as are required to produce a population that has among it a range of suitable individuals to satisfy the fitness criteria. They are widely used today in

control and optimization applications and the modeling of ecological
systems (Weinstock 2011, 164).[200]

Weinstock then connects these general models to the production of *architecture
of emergence.* It is the recognition of the importance and the relevance of
emergence as a complex model that relies on collective behaviour, stemming
from an interaction between an environment and an organism, that Weinstock
notes as lending easily to the application of GAs and, more specifically, in the
recognition of architecture as evolving over time and in exchange with the
environment. As Weinstock concludes:

> Emergence is of momentous importance to architecture, demanding
> substantial revisions to the way in which we produce designs. We can use
> the mathematical models outlined above for generating designs, evolving
> forms and structures in morphogenetic processes within computational
> environments. *Criteria for selection of the 'fittest' can be developed that
> correspond to architectural requirements of performance, including
> structural integrity and 'buildability'.* Strategies for design are not truly
> evolutionary unless they include iterations of physical (phenotypic)
> modeling, incorporating the self-organizing material effects of form
> finding and the industrial logic of production available in CNC and laser-
> cutting modeling machines (ibid., 166, my emphasis).

Despite this endorsement of GAs in the Emergent group's numerous
publications,[201] the technical discussion on the whole remains general, and the
exact methodology in terms of the application of GAs to their design process is
limited. One example of an in-depth methodological discussion is a joint paper
*Exploring generative growth and evolutionary computation in architectural
design*, a ResearchGate publication from 2006,[202] to which a group of researchers

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[200] See Michael Weinstock, "Morphogenesis and Mathematics of Emergence" in
Computational Design Thinking, Eds. Achim Menges et al. (Chichester: John Wiley & Sons, 2011),
158–167. This is a reprint of a text published in 2004 in Michael Weinstock, "Morphogenesis and
Mathematics of Emergence", *AD Emergence: Morphogenetic Design Strategies*, vol 74, no 3, John
Wiley & Sons Ltd (London), 2004, pp 10–17. This text is currently bound as part of a reader that
orients computtaional resarcher along biodigital architectture agenda and includes texts by
Goethe, D'Arcy Thompson, John Holland and John Frazer, along side Terzidis and Burry. It is
Achim Menges and Sean Ahlquist intellctual navigational tool, which complements Mario Carpo's
parametrics-centred readers.
[201]See below.
[202]Martin Hembers et al., "Exploring generative growth and evolutionary computation in
architectural design", last accessed 3 May 2016.
https://www.researchgate.net/profile/Achim_Menges/publication/266591010_Exploring_gener

from a number of institutions (Imperial College, MIT, the Bartlett, Southern California Institute of Architecture and the *Architectural Association* represented by Menges) contributed in evaluating a genetic computational design tool named *Genr8,*[203] which 'allows an architect or designer to both *grow* and *evolve* three dimensional *digital* forms or surfaces' (Martin Hembers 2006, original emphasis). Further, the developers make an interesting point in relation to the application of fitness factors to architecture:

> In design, there is no general way of algorithmically defining a 'good' surface. Coming up with a useful fitness evaluation scheme for design applications is still an open research question. In Genr8 we use a fitness evaluation scheme that gives the user high-level control of the evolutionary search. This has been implemented as a multi-parametric fitness function. Each parameter represents a specific feature of the surface […] The six criteria are size […] symmetry, soft boundaries […] subdivisions […] smoothness and undulation. It is important to point out that in most situations there are many different ways to attain a given fitness value […]. Consequently, there are many different surfaces which are equally good solutions for a given set of fitness criteria. This is an advantageous feature since it makes it easier to maintain a diverse population […] (Martin Hembers 2006, section 3.2, my emphasis).

The above is an example of design criteria for fitness factors, which reveals that the criteria do not leave the architecture-engineering comfort zone. Another interesting and revealing discussion concerns the authorship of Genr8:

> Genr8's use of growth and evolution yields a provocative and novel design process for an architect. Conceptually, the interaction and control between the architect and tool are radically changed. The designer has three means of controlling the design that emergently arises from interaction between computer and herself: 1) by setting up the digital physical environment 2) by supplying the growth instructions, and 3) by interactively guiding the evolutionary algorithm. In practical terms, the designer can interface with Genr8 either via a graphical user interface or

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ative_growth_and_evolutionary_computation_in_architectural_design/links/5440ebe30cf251bce
d614959.pdf.

[203] 'Genr8 is a plug-in for Alias|Wavefront's 3D design tool Maya and it was developed by the Emergent Design Group at MIT in 2001 […] At the heart of Genr8 is the growth algorithm for generating surfaces. The algorithm is based on Lindenmayer systems (L-systems)which have been widely and successfully used to model plant growth [13]. An L-system is a grammar, consisting of a seed and a set of production rules, plus a rewrite process in which production rules are repeatedly applied to the seed and its successive states […]', ibid., section 3, 3.1.

the Maya's built-in scripting language, MEL (Maya Embedded Language) (ibid., section 4).

This quote openly addresses the reluctance of the architects to give up control of the system.[204]

One of the examples discussed in the article is that of Achim Menges Project at the *Architectural Association*, where he used Genr8 'to embed the possibilities and constraints of fabrication and assembly processes already in the computational form generation' (ibid., section 5). While producing a sectional surface, the goal was to 'Design a pneumatic strawberry bar for the Architectural Association's annual end of year party' (2003), by utilizing 'the evolutionary dynamics of reproduction, mutation, competition and selection as design strategies' (2006). However, the main criteria, as Menges attests himself, were geometrical:

> specific geometric relations such as alignment and proportional distances of definition points, the individuals that shared these geometric features were selected. *Then the individual of the chosen species that grew in the last and most developed generation was picked* (ibid., my emphasis).

The geometry driving the selection was defined as a degree of plasticity that best suits the constraints of a digital cutting pattern and computer-aided manufacturing process.

> After running Genr8 for over *600 generations, 144 species were identified* and catalogued according to specific patterns of relevant geometric features. Considering the interrelated evolution of the geometry-defining surfaces the *criteria for evaluation was the relative fitness amongst the emergent species* rather than the absolute fitness ranking of any particular individuals (ibid., my emphasis).

The parameters chosen as fitness indicators are all structural, with no human consideration in terms of the experience related to the purpose of this object as a strawberry bar – ergonomically, sensually or culturally. Menges's focus on integrating the materiality of the object with its means of manufacturing has left

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[204] Their paper is a rare example of gender awareness in architecture, with a designer referred to as *her.*

on the sidelines other materialities – corporal materialities, which indicates the survivalist ethos of an evolutionary system.
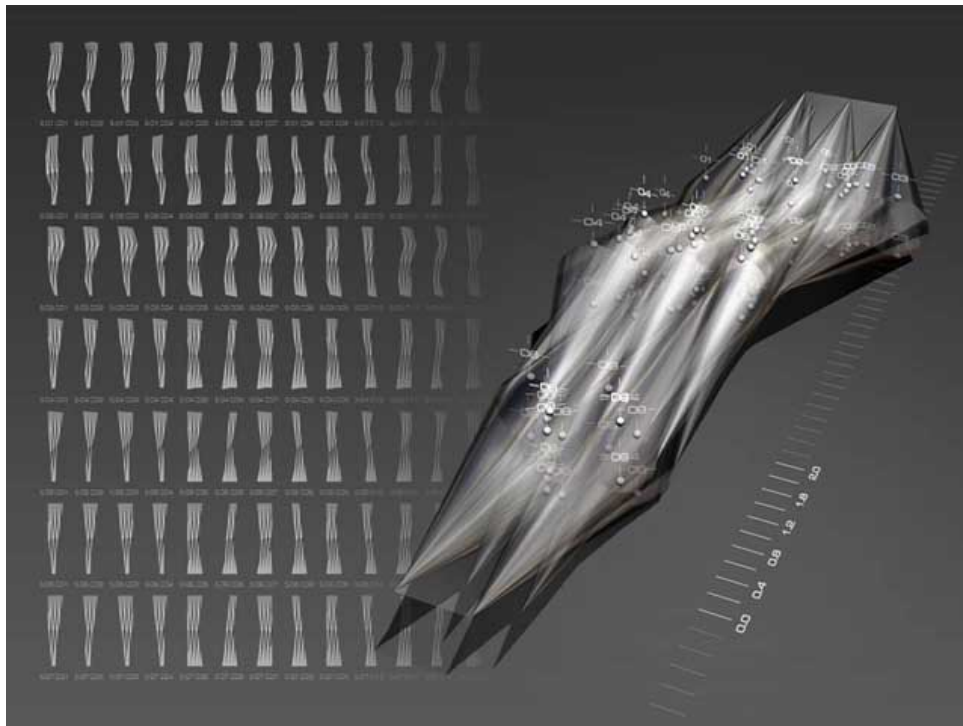
Figure 46: Achim Menges, Strawberry Bar's design 'evolution', Architctural Association, 2003
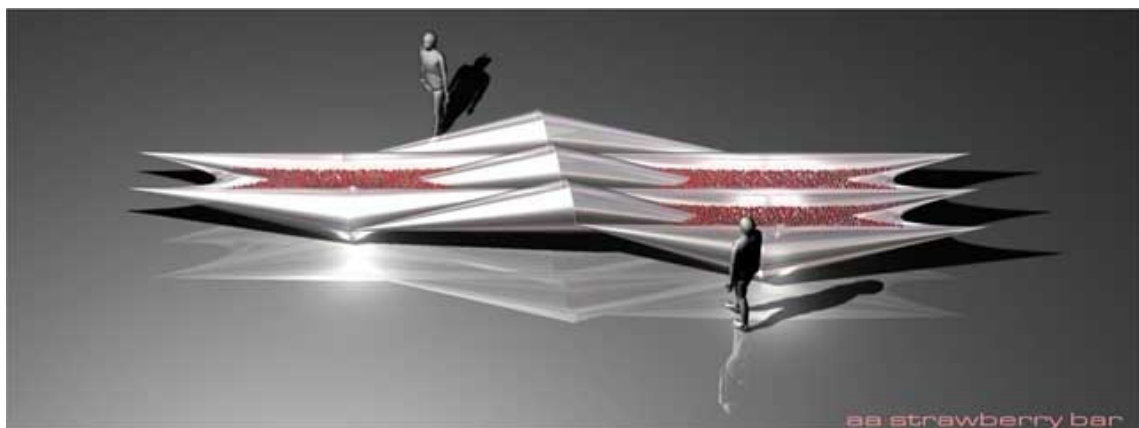
Figure 47: Achim Menges, Strawberry Bar, model, Architctural Association, 2003

Another example to such an approach is a 2004 design for a canopy to the AA terrace, the canopy being thought of in terms of protection from rain and sun while remaining flexible and strong enough to withstand the wind. This approach, it is stressed by Menges, embeds an ambition to fold together the performative and the constructural: 'Thus the morphogenetic process enables the balancing and calibration of multiple, or even conflicting, design criteria and

unfolding of the material system's inherent performative capacity' (Menges 2010, 59). Nevertheless, the performative is being reduced to a deterministic set of parameters that guarantees the satisfaction of basic needs. This is a skeletal approach, which does not take into consideration our singular corporality, enabled by the traditional focus on the structural as a universal engineering matter, as architectural materiality outside the corporal, in its full binary. This skeletal approach to architecture results from Menges' narrow understanding of evolutionary processes.

The feminist architectural historian and critic Christina Cogdell has recently compared the use of GAs in digital architecture with eugenic practices when it comes to *fitness,* pointing to problematic similarities between eugenics and generative architectural digital approaches and techniques: [205]

> 'Fitness' was assumed to entail criteria of race, class, sexuality, and ability as demonstrated by the less-than-subtle innuendo of a Mendelian lesson about color inheritance in Guinea Pigs, displayed by the American Eugenics Society at state fairs in the 1920s (Cogdell 2015, 125).

Furthermore, claims Cogdell, if the oversimplified notion of mimicry is to be practised, and 'if architects choose to talk and act like these entities are equivalent through biological exaggerations, then the socio-political eugenic implications of evolutionary computation have to be taken very seriously' (ibid., 135). Cogdell concludes that: 'Architecture and biology are inextricably socio-political' (ibid., 136). Beyond the provocation, Cogdell's critique carries an important message questioning the perceived neutrality of the sciences and their matter-of-fact immersion into the architectural discourse without contextualizing these (and other) practices. The above cartography shows that these pre-assumptions are already folded into the biodigital architecture processes as excess baggage from the entanglement of current architectural thinking with other disciplines. Therefore, unpacking this excess baggage also enables new alignments.

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[205] See Christina Cogdell, "Breeding Ideology: Parametricism and biological architecture", in Matthew Poole et al., ed., *The Politics of Parametricism: Digital Technologies in Architecture* (London: Bloomsbury, 2015), 131–5.

Achim Menges – Towards a Novel Material Culture/Complexity Theory at the Service of Humanist Thought

The following discussion concerns a further shift in biodigital design, that relocates the evolutionary processes to the realm of the molecular materiality make-up of the architectural object, and as such, challenges the concept-material modern-humanist divide. Such new design epistemology holds great promise for a reconceptualization of subjectivity for it suggests a further undoing of the traditional register of the subject – that of the subordination of materiality to thought and body to mind. This was already implied in the ambition of the move to algorithmic design. However, in the case of this current digital phase, the materiality of the digital output is no longer computational/ virtual – the new architecture assumes an ambition to write in the matter of architecture itself.

2008 marks a shift to a new methodology deployed by Menges, critiquing the traditional separation between concept design and detail design, he proposes an alternative; a 'morphogenetic approach to design that unfolds morphological complexity and performative capacity from material constituents without differentiating between formation and materialisation processes' (Menges 2010, 44).[206] This shift takes place alongside a geographical move – from the Emarch programme at the Architectural Association to the University of Stuttgart, where Menges was given the academic freedom to pursue his interest as the head of the newly founded Institute of Computational Design (ICD). In a 2015 interview, Menges explains his move to the University of Stuttgart as influenced by the university's overall material-oriented and interdisciplinary design approach, a legacy left by Frei Otto, according to which 'materials are not passive receptors of pre-designed form but are generative drivers in the design process' (Menges 2015a). The university location, in the heartland of German engineering culture,

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[206] Such separation is engraved into traditional design process and codified by the Royal Institute of British Architects (RIBA). For ' best practice' building stages, see "RIBA *Plan of Work*", last accessed 28 April 2016.
https://www.architecture.com/files/ribaprofessionalservices/practice/ribaplanofwork2013template.pdf.

played another part in his move.[207] The new post marks a clear move away from an elaboration on GAs as the main driver behind morphogenetic processes to other methods of evolutionary computation, already in place in his early projects:

> Similar to algorithmic growth processes, evolutionary computation offers different ways of implementing such generative processes and fitness evolution techniques. What all such procedures generally have in common is using the evolutionary dynamics of combination, reproduction and mutation of the underlying genotypic datasets through a generic algorithm as well as selection procedures (Menges 2010, 56).

Menges argues for a computational potential to profoundly change our conception of materiality, which from an architectural standpoint will change the relationship between the process and the physical making of the built environment. His agenda is to reverse the longstanding separation between the architect and his creation that was introduced in the Renaissance. This separation created a professional architect detached from the building industry – no longer the master builder. Computation, argues Menges, allows for an active perception of materiality, which is no longer separated from the physical realm:

> Computation is emerging as a key interface for material exploration, enabling engagement with aspects of the material world that until recently were too far removed from the modalities of designers' sense and intuition. This represents a significant perceptual shift in which the materiality of architecture is no longer seen as fixed property and passive receptor of digitally derived form, but it transforms into an active generator of design and an adaptive agent in architectural performance. Similarly, and in stark contrast to previous linear and mechanistic modes of digital fabrication and manufacturing, materialization is now starting

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[207] Menges elaborates on the importance of Frei Otto's legacy at the University of Stuttgart as well as on the importance of the geographical location of the university to his research in an interview in the online architectural magazine *Uncube* in 2015: 'Another thing I really appreciate also about the University of Stuttgart is that it's situated within the heartland of German engineering culture. I'm not only talking about structural engineering, but also about production engineering and manufacturing. We find a lot of support comes not only from within the research and academic system, but also from industrial partners. What may be unique to this area is that industry sees the necessity to remain innovative, especially because the industry in the south of Germany cannot compete on price but only on innovation and quality.' See "Into the Cyber-physical: an Interview with Achim Menges," last accessed 12 May 2016. www.uncubemagazine.com/blog/15572449,

to coexist with design in the form of explorative cyber-physical processes (Menges 2015b, 9).

Menges sides with past 'truly generative material exploration in design, such as manifested by Otto and Josef Albers' (Menges 2015b, 10).[208] In this respect, Menges is part of a lineage of materialist architects, influenced by Frei Otto's unmediated material experimentation, who sees in the introduction of computation to the discipline an opportunity to be reunited with the materiality of architecture, which historically presented a critique of modernism. Its digital iteration is still being positioned as a critique, as a;

> challenge to both current digital design approaches devoid of material logics and the aforementioned, trite, modernist 'truth to materials' that lingers on in today's design thinking and relates the assumed essence of a material to a set of given – supposedly appropriate – structural and spatial typologies. A prime example of equating a material's quintessence to a defined constructional logic in such a linear, direct and idealist manner is the topological response that brick whisperer Louis Kahn imagined to receive (ibid., 12).

The new design ambition is met with a new methodology that respectively shifts the interests of the early biomimetic processes from morphogenesis to the molecular study of material performance in various species. Or, in other words, biomimetic processes no longer rely on computational models generally mimicking biological evolutionary models, but have moved to mimic the organic material itself. To this end, Menges' lab focuses on fibre-constituted materials while investigating the correspondence between their molecular make-up and those of organic precedence in a series of pavilions constructed on a University of Stuttgart site. I refer here to the 2013/14 ICD/ITKE research pavilion (Constructed by the ICD, run by Menges and the Institute of Building Structures and Structural Design (ITKE).

The ambition behind the pavilion is the realization of an interdisciplinary design

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[208] Josef Albers' material studies were conducted at the Bauhaus in Dessau in the late 1920s, a work that was pursued later at the Black Mountain College in North Carolina. (Stated dryly, no reminder of the historical circumstances that led to that geographical move). Menges observes that Josef's models '... were not conceived as scalar models of representations of ideas, but rather as a generative unfolding of material behavior in space and time from which hitherto unsought design possibilities could originate'. See Menges, *Towards a Novel Material Culture*, 2015, 10.

research study on transferring principles of biological composite morphology to architecture, by extending the use of coreless filament winding processes to the construction of modular and robust double-layered shells. Through the development of computational design and simulation tools, both the robotic fabrication characteristics and the abstracted biomimetic principles are being simultaneously integrated in the design process.[209] In the development of this pavilion, Menges and his team's departure point was a material-structural enquiry into a wide range of biological fibre-composite structures, which brought them to the morphology of a potato beetle elytra:

> The ICD/ITKE team continued the interdisciplinary design research on transferring principles of biological composite morphology to architecture, undertaken for the 2012 pavilion, to extend the use of coreless filament winding processes to the construction of modular and robust double-layered shells. The screening of a wide range of biological fibre-composite structures revealed the morphology of beetle elytra – the hardened forewings that protect the fragile flying wings against mechanical impact load – as a particular lightweight structure. *The weight-to-structural-capacity ratio is a predominant fitness criterion in flying beetles*, and the elytra thus evolved to become double-layered composite shells that achieve an extraordinary level of material performance through differentiated fibre organization (Menges 2015c, 56).

It is interesting to note that, when discussing the reason behind moving their focus to fibrous compositions, the only parameter that is considered is *performance.* The adaptation of the performative and the structural composite is only considered in relation to environmental influences and forces. It is the arrangement of the fibres that controls their performance, and this is the level of material control that Menges and his team hope to achieve via current leaps in computation and fabrication.

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[209] Menges credits a long list of collaborators. 'Institute of Evolution and Ecology, Evolutionary Biology of Invertebrates, University of Tübingen; Department of Geosciences, Paleontology of Invertebrates, University of Tübingen; Module Bionics of Animal Constructions, University of Tübingen; ANKA / Institute for Photon Science and Synchrotron Radiation; Karlsruhe Institute of Technology (KIT); Institute for Machine Tools, Universität Stuttgart; and Institute of Textile Technology and Process Engineering ITV Denkendorf. See Institute for Computational Design at the University of Stuttgart site: http://icd.uni-stuttgart.de/?p=11187, accessed November 2016.
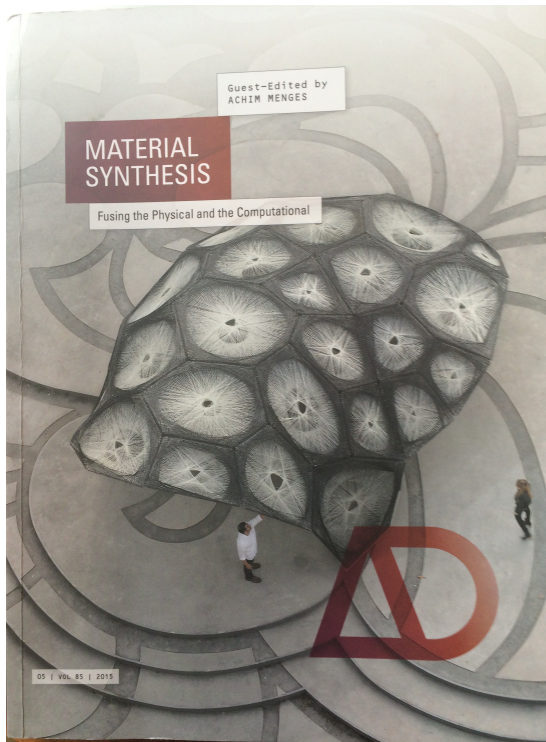
Figure 48 (left): Architectural Design,
Material Synthesis: Fusing the Physical and the Computational, guest-edited by Achim Menges, 2015,
publication cover image

Figure 49 (right): ICD/ ITKE Research Pavilion 2012, University of Stuttgart

Figure 50: ICD/ ITKE Research Pavilion 2012, University of Stuttgart
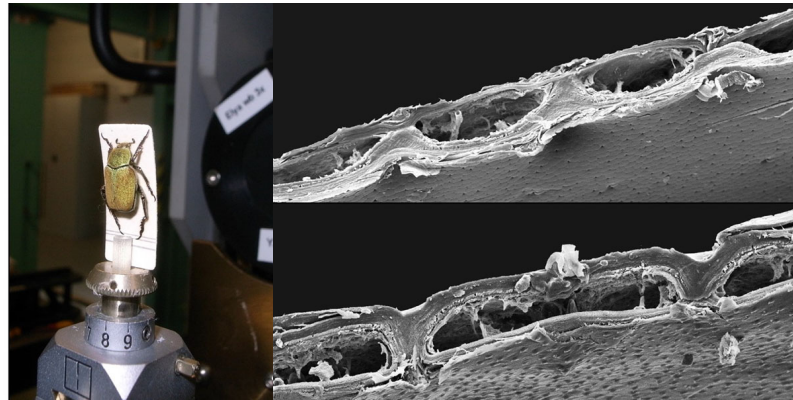
Figure 51 (left) : ICD/ ITKE Research Pavilion 2012, biological research
Figure 52 (right): IC D/ ITKE Research Pavilion 2012, performence study
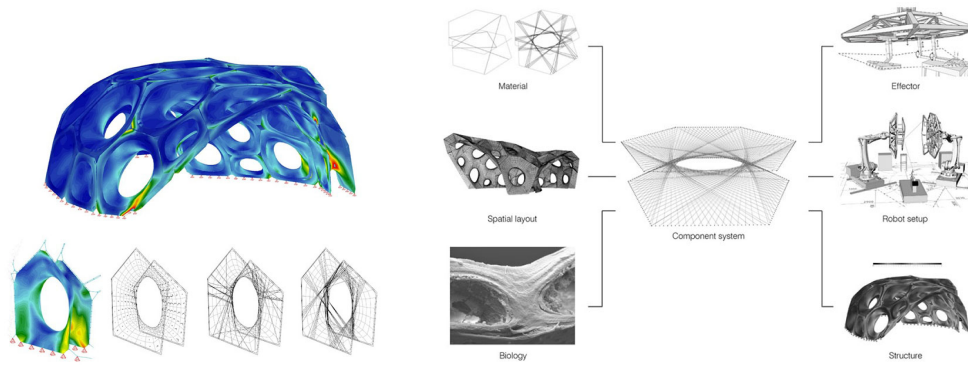
Figure 53 (left): ITKE Research Pavilion 2012, Structural study
Figure 54 (right): ICD/ ITKE Research Pavilion, 2012

Figure 55: ICD/ ITKE Research Pavilion 2012, robotic manufacturing.

There is a strong emphasis on natural precedence and material behaviour as part of this design process. For example, Menges refers to the Eameses as one of the first examples of pioneering experimentation in fibreglass, but simultaneously points to a crucial difference in approach between the height of the modernist application of fibreglass and his current approach to composite materials. While the Eameses adopted fibreglass as a cheaper and lighter alternative to plywood, the Eameses methodology nevertheless maintained similar techniques of molding fibreglass as they used for plywood, hence the non-material led approach was maintained. For Menges, fibre is the starting point, which then leads to the final structural and formal end-result deriving from the calculated relationship between the material and its environment, as complied with materialist and emergence theories. This entailed a rethinking of composite structures not as the direct imprint of a mold, but rather as emerging from the complex interrelation and procedural characteristic of the fibres in space and time during fabrication (Menges 2015c, 56).

Nevertheless, when considering Menges's study of the beetle fibre composite, a functional, skeletal approach to architecture appears, resulting from the above-mentioned deterministic conception of evolutionary processes. The term skeletal already implies a modern appreciation of the organs dissected and divided into vertical phyla, such a common scientific approach of segregation preventing an appreciation of other ecologies to inform and be informed by. The result is an isolated, functional investigation of a specific feature (the beetle wing), disregarding its environment where the wings fulfil other purposes rather than the merely structural – they buzz, and dazzle, communicate and bewitch, resonate and reflect and form part of an ecology. A similarly skeletal approach to the environment is manifested in the parameters dictating the overall formal solution, which stem from a *performative* definition of the material responding to external, universal forces. In other words, the skeletal should be understood from a corporeal perspective, or its lack – as that which does not take into consideration our corporality in all its dimensions. The design process not only mimics the beetle's load-bearing rigid external wings in isolation, it also entails parameters informing the pavilion design that are isolated from a human

environment – the designer or the user's. From this standpoint, Skeletal equates disembodied.

This paradox of a biomimetic process that neglects the biological framed as corporal, in all species, is expressed by Braidotti as the condition of our postmodernity, in terms of the overexposed and at the same time disappearing concept of the body.[210] Moreover, mathematics follows biology in discovering new forms, while still manifesting a colonializing methodology of isolation and exploitation.[211] However, while in the past colonialism was inscribed in the flesh, the current round of biocolonialism releases itself from bodies and organisms, and moves to operate in the axiomatic abstraction of the process, flows and molecules. Ansell-Pearson refers us to *Anti-Oedipus,* where Deleuze and Guattari argue that this is not to suggest that the inscription is not there, but that it is more elusive to pin down.[212]

> The axiomatic does not need to write in bare flesh, to mark bodies and organs, nor does it need to fashion memory for man. In contrast to codes, the axiomatic finds in its different aspects its own organs of execution, perception, and memorization […] despite the abundance in identity cards, files, and other means of control, capitalism does not even need to write in books to make up for the vanished body markings. Those are only relics, archaisms with a current function. The person has become 'private' in reality, insofar as he derives from abstract quantities […] it is these quantities that are marked, no longer the persons themselves (Deleuze and Guattari 2004 [1972], 272).

I find this shift relevant in framing the discussion of Menges's molecular focus, precisely because, in light of the above, it takes more than the molecular to differentiate, where the axiomatic does not need to operate at a typological level in order to inscribe on us; rather, it has moved to work in the darkness of the digital code and its many layers of axiomatic thought that is inscribed on it.

This material methodology is nevertheless a hybrid. On the one hand, it is non-dualist and non-representational and its processes as it moves towards a

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[210] See introduction, on our post-human condition and the need for figurations.
[211] Braidotti refers to such practice as the cannibalization of nature. See Rosi Braidotti, *Transposition,* 46–8.
[212] Ansell-Pearson, *Germinal Life,* 217.

dynamic appreciation of formal differentiation, and on the other hand, it is framed by humanist ontology that is disembodied and universal as well as human-centric and colonial in its relations to the *non-human.* That is, still separates and ignores the flows of imperceptible ecologies in a binary of inside and out. How can this material process be taken to another level of connectivity that is inclusive of other needs, a multi-layered site, responsive to all ecologies? To that end we require an embodied and relational design process that is immersed in the materiality of a body on all its dimensions. At the same time, and as a means of uprooting inherent humanist traditions in architecture, it is not enough to focus this design process on the notion of evolutionary process in relation to one entity, we need to consider our *eco*logy and consists it in the context of a digital environment. The coming discussion retraces new potential discursive alliances as alternative conceptions to evolution and environment.

Evolution As Expansion/ from Autopoiesis to the Machinic Phylum
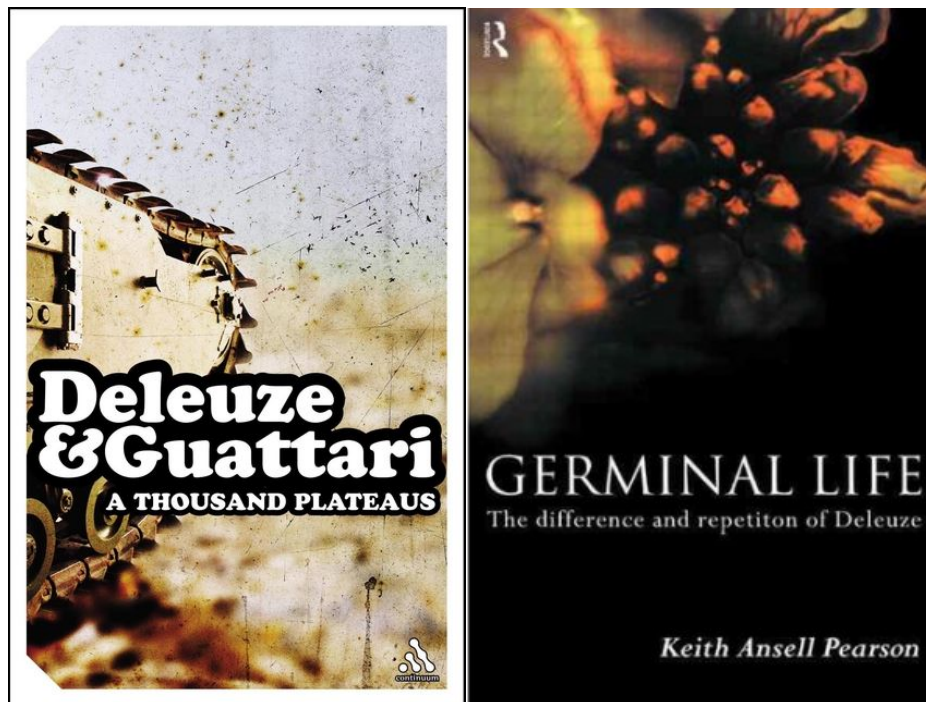
Figure 56 (left): Deleuze and Guattari, A Thousand Plateaus, 1980, book cover image
Figure 57 (right): Keith Ansell-Pearson, Germinal Life: The Difference and Repetition of Deleuze, 1999, book cover image
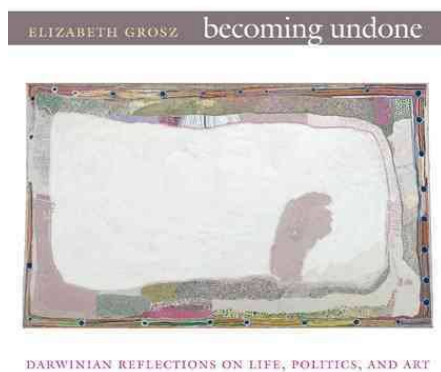
Figure 58: Elizabeth Grosz, Becoming Undone, Darwinian
Reflections on Life, Politics, and Art, 2011, book cover image

Umwelt, autopoiesis – the organism

The cartography of the underpinning biological theories of GAs and consequently of biodigital architecture points to an emphasis on a genetic-focused evolutionary process as the main determination and source of differentiation. This is a dated view of evolutionary processes, which sidelines alternative theories that, although not debating the power of evolution and the place genetics plays in these processes, nevertheless is not in itself perceived as holding the power to determine. There is more to evolution than natural selection, and there is more to differentiation/ individuation than the genetic distribution determined at the embryological state, implied in the architectural process.

Within biological circles, the first assumption has already been contested for the past decade. For example, we are reminded of the limitation of the genetic-oriented perception of evolution by Evelyn Fox Keller, in her book *The Century of the Gene* (2000).[213] Genetic, epigenetic and post-genomic are three concepts offered by way of critique on the far-reaching hubris underlying the genome project, as well as the realization of the discrepancy between the simplicity expressed at the outset of the project for it to illuminate our origins and the current far more complex understanding, as she recalls:

> a decade ago, many biologists spoke as if sequence information would, by itself, provide all that was necessary for an understanding of biological function. Spelling out his 'Vision of the grail,' Walter Gilbert wrote, 'Three billion bases of sequence can be put on a single disk (CD), and one will be able to pull a CD out of one's pockets and say. "Here is a human being, it's me!"' Today [2000] almost no one would make such a provocative claim. Doubts about the adequacy of sequence information for an understanding of biological function have become ubiquitous, even among molecular biologists, and largely as a consequence of the increasing sophistication of genomic research. By and large there is a departure from mid twentieth century hope that saw the genome project as a 'Rosetta stone' (Keller 2000, 6–7).

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[213] Evelyn Fox Keller, an American scholar (MIT), has devoted her research to critiquing the disembodiment of scientific conventions, especially around questions of gender. Her work has helped to entice a critique of the scientific process and has questioned our fundamental understanding of science within Western culture and civilization. I have referred to her writing through the work of Braidotti earlier, in cartography 1 of this chapter, as the genetic inspiration behind *Transpositions.*

This restrained appreciation regarding the power of genetics to determine the evolutionary process developed over the past two decades in biological research is not manifested in the current biodigital discourse, in part because the 'translation' of, the by now outdated, Darwinian principles took place in post-war USA, when the promise of science to predict and explain all forms of natural behaviour was at its zenith. It is time biodigital methodology in architecture be revisited to allow for a more nuanced and ecological viable understanding of human and non-human life. The account to follow traces such alternatives. What affective reconceptualization of the differentiating processes that undoes the above reliance on rational and instrumental criteria, albeit in a generative environment can we suggest as an alternative?

Elizabeth Grosz traces such an extension in her *Becoming Undone*: *Darwinian Reflections on Life, Politics, and Art* (2011):

> This book is devoted to an exploration of the various excesses that forms of life engender: excesses of creativity, intensity, sexuality, and force that produce life as more than itself, a form of self-overcoming that incorporates matter and its capacities for self-overcoming within its own becomings. This capacity for self-overcoming is the condition for the emergence of art, for the eruption of collective life, and for the creation of new forms of politics, new modes of living (Grosz 2011, 8).

This expansion of life is aimed at introducing a revised understanding of her reading of evolution and Darwin. I see Grosz's contribution in emphasizing the non-human in this process, which brings to the fore affectual alternatives to the process of differentiation we witnessed so far, that which values functional and instrumental, as well as universal and human-oriented definitions of fitness and selection. Grosz turns the discussion of evolution from questions of differentiation to questions of individuation, reiterating the notion that Darwin was the first in the chain to release man from the centre of the universe – the first in the chain to undo man. The project that Bergson and later Deleuze have taken upon themselves is to re-immerse man/ human in a world of materiality, maintains Grosz.

> If Darwin demonstrates man's immersion in and emergence from animal (and ultimately plant) life (or even life before plants and animals

separated), it is Bergson, and through him Deleuze, who demonstrates man's immersion in and emergence from the inhuman, the inorganic, or the nonliving (ibid., 27).

In more specific terms, Grosz reiterates the differentiation drive of the evolutionary project, which she does through a reworking of Jakob von Uexküll's concept of *umwelt.* Jakob von Uexküll (1864–1944), the Estonian biologist and ethologist, was interested in understanding the worlds, which animals inhabit from their own perspective.[214] Grosz positions his work as connected to a lineage of 'vitalist or biocentric works' that runs from Schelling to D'Arcy Thompson and through to Oliver Sacks. It is interesting to note that 'It is really Deleuze who hijacks him from this lineage to place him within the context he shares with others concerned with the elaboration of technology and materials' (ibid., 173).[215]

In this thesis the discussion of *umwelt* is framed as an elaboration of affective qualities behind what we broadly refer to as process of 'natural selection', and therefore as an expansion of what evolutionary process may entail – this is in direct correspondence to the reductionist evolutionary processes drawn upon in biodigital discourse. A second understanding of the role of *umwelt* in this thesis relates to the reconstruction of the monad along nomad lines discussed in the previous cartography, which leads me to examine the re-articulation of *umwelt* in a nomadic world, for the premise and mechanism of the notion of *umwelt*

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[214] The renewed interest in Jacob von Uexküll's work is mentioned by Keith Ansell-Pearson, who frames it as part of growing interest in 'a more embodied, contextualized, and dynamical approach to intelligence.' See Ansell-Pearson, *Germinal Life,* p. 170.

[215] Uexküll's was rediscovered by Deleuze and Guattari and is mentioned in *A Thousand Plateaus,* as part of a Spinozist *becoming animal*. See Deleuze and Guattari, *A Thousand Plateaus*, 283. Ansell-Pearson describes this encounter in the following: 'In both 'Memories of Spinozist II' in *ATP* and "Spinoza and us', […] Deleuze links together Spinoza and Uexküll in terms of an ethology of affect in which the emphasis is placed on the way in which animals construct the 'outside' in terms of an interiorization involving milieus of affect.' See Ansell-Pearson 1999, 187. *Umwelt* is being used in architectural context as a general example of affective turn and as part of an ecological environment. See Sanford Kwinter, "Ecological Thinking", a lecture in *proto/e/co/logics speculative materialism in architecture* (Croatia: 6 August 2011)*,* https://vimeo.com/28810672, last accessed May 2012. See also Peg Rawes, "Spinoza's Geometric and ecological ratios", in *The Politics of Parametricism, digital technologies in architecture,* Eds. Matthew Poole and Manuel Shvartzberg (London: Bloomsbury, 2015), 221. Rawes refers to *umwelt* as part of a critique of parametricism's limited conceptualization of environmental awareness. Rawes draws back on Grosz to construct *umwelt* as an example to an embodied 'Biopolitical geometric ratios'. In the context of this thesis, *umwelt* designates an affective and relational process as in the context of alternative and nonunitary models of post-human subjectivity. That is to say that I remove the concept from its general ethological context.

corresponds to that of the monad. Undine Selbach and Stephen Loo, in their text *Insects and Other Minute Perceptions in the Baroque House* (2015), point to the ties linking Uexküll's scholarship to Leibniz and also to the ties connecting Deleuze's own scholarship with Uexküll's ethology, through the work of Bergson.[216] In the closing part of this cartography I therefore theorize the premise of *umwelt* in the nomadic world replacing the monadic, or in other words, this closing section highlights the importance of *umwelt* in a nomadic and multiple world in a way which rearticulates the importance of nonunitary subjectivity to other wise universalist biodigital discourse. That is to say that drawing on the ethologist lineage of *umwelt* is not seen as a goal in itself but rather as an opportunity to reevaluate the ontological in Deleuze's nomadic world, and how such reconceptualization may in turn inform biodigital and other architectural discourse.

Grosz's discussion of the notion of *umwelt* highlights the importance of a dynamic 'milieu' – an ecology constructed between organisms. Each milieu is identified with musical qualities, harmonious ones. The importance of the concept of milieu is the creation of an ecosystem relating individual organisms: 'These are no longer autonomous entities, self sustained organisms, but operative pairs, a duet, two entwined melodies, which may function without the other, but which open up and resonate only together' (Grosz, 174) – for example, bees and flowers. However, each organism perceives the milieu differently:

> Uexküll argues that an animal is not immersed in its entirety in a given milieu, but discerns only certain features which are significant to it, those which are in counterpoint with its own organs. Each organism is surrounded by its *Umwelt*, an 'island of the senses,' the schematized world in which it acts. The Umwelt, the 'soap-bubble' in which each living being is housed, is the world provided to it by its receptor organs, its sense or perceptual organs, and through its organs of action, effector organs, double pincers through which the living being engages with and forms part of the natural world. The Umwelt is the particular world, a subsection of partial framing of the more abstract material universe, to which living things, including the human, have only limited access (ibid.).

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[216] See Selbach and Loo, *Insects and Other Minute Perceptions in the Baroque House*, 110.

Perception therefore is a derivative of the organism's organs; it produces an angle, a partiality;

> The Umwelt is the particular world, a subsection or partial framing of the abstract material universe, to which living things, including the human, have only limited access; it is a sliver or fragment of a world which is fully accessible to no living being [...] For Uexküll objects are not cohesive sets of qualities but opportunities for engagements, for action, that offer themselves in particular ways to particular organs and otherwise remain indiscernible. Objects are pragmatically accessible; thus living beings, animals cannot be construed, as they have been in modern philosophy since the seventeenth century, as complex machines or automata. Organisms are sense-bubbles, isolated worlds, monads composed of fragments of milieus and organs, musical counterpoints creating a melody. The umwelt is a sensory world of space, time, objects, and qualities that form perceptual signs for living creatures, the world that enables them to effect actions, to exercise their organs, to act (ibid., 175).

This non-dualist and affective understanding of the relationship between the organism and its environment entails different object conception for each organism. 'One and the same object on entering different Umwelten becomes different' (ibid.). This entails a different take on the utilitarian and survivalist evolutionary process, which Uexküll replaces with '"musical" or harmonic "laws of life"' further quoted by Grosz: 'It is thus musical and not mechanical laws that we need to study if we want to find out about the laws of Life"' (ibid., 176). Grosz reflects on the meaning of this reconceptualization, stretching the utilitarian, Darwinist world on our own world. 'How does it help us understand the animal in us, the animal from which we have come, and the animal that still dwells within us?' (ibid.). The answer to which is, 'through our own perceptual organs, through the lens of our own *Umwelt*' (ibid., 177), argues Grosz through Uexküll. Grosz places the significance of *umwelt* not only in terms of a single species, but on the inter-*umweltian* exchange, organisms of all kinds should not be understood in isolation, but rather, 'we need to understand that the units of evolution are neither individuals nor species; rather the living creature, individual and species, is fully immersed in an *Umwelt*' (ibid.). This entails that the biodigital model according to which, active environment is acting upon a passive organism, dissected into parts should be revisited.

The other implication is on the viability of fitness as the main criteria for selection, or rather an expansion of what it entailed to be fit is required. This is to suggest an alternative to the deterministic and eugenic practices understood to be underpinning selection to include the imperceptible stemming from an affective relationality between the organism's sensual world and the environment. This theory not only replaces the criteria behind selection depicted in this narrow reproductive drive of species approach, it also suggests a revised understanding of the practice of selection. This alternative process also entails a dynamic exchange between organisms and environments that replaces the one-sided flow of information from an external environment to an organism, towards an internalizing process, according to which the environment is already incorporated by the organism, described as a capacity to be in the world in a certain way, to attract and detract. Following on Uexküll, Grosz's extension of the notion of selection allows us to step away from the prevalent functional and reductive conceptions of fitness (as a preference to a condensed ideal gene pool), to include other ecologies and other patterns of differentiation and of coming together that are imperceptible and which do not give us access to a known future, or to a known pool of potentiality, or probable choices.

Umwelt therefore is a recognition of an embodied and embedded organism's becoming. Such a theory accounts for the singularity of an organism to inhabit certain iterations over a given period of time and space, not only because of a genetic trajectory, but also because of an affective relationality that is singular to a specific organism in its relation with its environment as it is formed by its sensorial bubble. Already the correspondence between the construction of *umwelt* and that of the monad becomes apparent. This process of becoming, not unlike Leibniz's process of differentiating points of view, apperceptions differentiating minute perceptions from a singularity reiterated in biological terms, enabled by having a body. *Umwelt* is a departure from the pre-human world inhabit by Leibniz's monads; on the one hand, both worlds are limited in the sense that their outcome is one of harmony; however, both the monad and the *umwelt*, are linked by the same process and by the same mechanism, both entailing a process of derivation of perspectives, of subjectivities (if we are to use

human terminology), enabled by having a body (human or non-human) understood as organs of perception (of any kind), a process that is identical in its mechanism, however differentiated according to the capacity of each organism's organs to affect and to be affected by their milieu. In both cases, that of the monad and that of the *umwelt,* this complex process's emphasis is placed on the imperceptible that escapes a deterministic scientific model.

Selbach and Loo, who also theorize the correspondence between monad and *umwelt*, highlight the instrumental role Uexküll's theory plays in Deleuze's ecological thinking, while critiquing Deleuze's take on these theories in regard to 'a paradigm of affect' being an outcome of 'symbiotic processes in biology' which, they argue, impact 'the ethical implications of our relation with nonhuman world' (Selbach and Loo 2015, 115). This brings them to another concern of the importance affect plays in Deleuze's reconceptualization of the human, arguing that 'if we think only in terms of legible bodily capacities, and allow for the distinct bubble world of other animals to vanish' we may lose Uexküll's 'potential productive instability' (ibid., 116). Instead, and in accordance with Leibniz, Selbach and Loo suggest focusing the discussion on the 'tactility of matter' not already in the realm of affect, but rather in the realm of minute perceptions 'on the brink of being felt, by humans and by other nonhuman life forms' which in turn 'brings with it new modes of attention and comportment for an ecologically oriented ethics' (ibid., 117). Minute perceptions not yet in the register of affect are also understood by Selbach and Loo as a way forward in a world of disaccord because they allow for 'differentiations that are proper to the *umwelt,* first between the clear perceptions leading to expressions of the world and the minute perceptions within an *umwelt*, and second between the minute perception and the periphery of one *umwelt* to another' (ibid., 119). Describing thresholds inter-affect as the areas of real difference.

As I showed in the previous cartography, Deleuze's stance in regard to the shift from *umwelten* of harmony to those of disharmony should not be looked 'back' at in nostalgia for a lost world, but rather, drawing on multiplicity as an expansion of the possible connections, some of which cannot be aligned, while others hold the potentiality to new lines of flight. What promise does this shift hold for our

definitions of the *umwelt*? How does *umwelt* pronounce itself in a world of multiplicity, in a nomadic world? I move on to discuss the *machinic phylum* as a potential way out of the issues presented by affect.

The germinal and the machinic – nomadic transposition

A recent example of a process that overrides or at least compensates for not only the rule of DNA, but that highlights the importance of a complex ecosystem to processes of determination is a new study evolved in the Weitzman Institute of Science, Israel, by two young scientists, Eran Elinav and Eran Segal, an immunologist and an applied mathematician respectively, who emphasize the personalized aspect of the intestinal microorganism's make-up as an ecosystem, an ecosystem ignored by evolutionary studies because it does not form part of a human DNA.[217] Their research shows that it nevertheless has a far-reaching impact on human metabolism, immunology, the nervous system and the development of other organs.[218] According to the findings of their research, the human gut consists of 95% non-human cells: bacteria, viruses, parasites and fungi, whose genes collectively outnumber the amount of human genes by a factor of 100. Prior to earlier beliefs, these are not passive environments but, rather, generative ones that are in constant communication with their 'host'.[219] The above gives a completely different appreciation of the relevance of overarching evolutionary theories and questions an essentialist approach, which

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[217] See "Elinav Lab", last accessed September 2016. http://www.weizmann.ac.il/immunology/elinav/

[218] 'For a long time, it was thought that these microorganisms were mostly passive members of the human ecosystem, with mostly digestive functions in the intestine. It is now clear, however, that the members of the microbiota are an integral part of human physiology. Microbial presence and activity influences the function of the immune system, nervous system, metabolic system, as well as organ development. In addition, microbial colonization is influencing a large variety of disease processes, ranging from chronic inflammatory disease to autoimmunity, obesity, and cancer. As such, the microbiota can be viewed as an additional human organ system, comprising a multitude of cells, genes, and metabolic pathways, which performs pivotal functions in health and disease.' See "Elinav Lab", last accessed September 2016. http://www.weizmann.ac.il/immunology/elinav/content/microbiota. In a different publication, these findings are linked to a shift towards individually tailored medicine: 'In recent years modern medicine is rapidly shifting from classical approaches focusing on disease-centered diagnosis and treatment paradigms, to a more individually tailored approach termed personalized medicine. Personalized or precision medicine is defined as treatment targeted to the individual patient on the basis of genetic, phenotypic, biomarker-based and possibly environmental and psychological factors that distinguish one patient from others with similar clinical characteristics.' See "Elinav Lab", last accessed September 2016. http://www.weizmann.ac.il/immunology/elinav/sites/immunology.elinav/files/2016_elinav_j_diabetes.pdf.

[219] Ibid.

is being rejected in favour of a dynamic and molecular model. This is literally germinal life.

This example speaks of the importance of affectual relationship as means to overcome our human limitations on the one as well as to create connections with the non-human. I suggest discussing this shift from an organism to an ecosystem with Deleuze and Guattari's *machinic phylum*. I suggest that the *machinic* phylum introduces the notion of multiplicity, or nomadism into the ecological process of becoming by way of shifting the discussion from autopoiesis of a single organism to that of its ecology in a way that allows room for other relationalities, other than Uexküll's harmonious duets. This shift also undoes the monadism entailed by autopoiesis in terms of an organism being an enclosed system, this term of enclosure is explained by Ansell-Pearson as that 'which does not mean that they [autopoietic entities] do not interact with an environment but rather that such interaction is always informed and determined by the organization of the particular autopoietic entity' (Ansell-Pearson 1999, 169). Framing the move to a nomadic understanding of autopoiesis as the need for 'articulation of a *distributed* conception of agency. The challenge is to show that "nature" consists of a field of multiplicities, assemblages of heterogeneous components (human, animal, viral, molecular, etc.), in which "creative evolution" can be shown to involve blocks of becoming.' In such an environment, claims Ansell-Pearson, 'ethology' loses its classical focus on 'Behaviour' and becomes concerned with directional movement of assemblages' (ibid., 171) that do not distinguish between orders or hierarchy of forms.

Further, Keith Ansell-Pearson places the machinic phylum in the context of a greater Deleuzian effort to resist post-war neo-Darwinism's reductionism, tracing Deleuze's introduction of machinic thinking back to *Anti-Oedipus*, as marking a shift from his independent work:

> in his collaborative work with Guattari, Deleuze is no longer addressing the 'becoming' of the human as a question if its 'evolution' as an individuated *biological organism* (any attempt to apply the charge of biologism to his work is based on a colossal misunderstanding and the most cavalier of readings he further claims). The 'human' is now

understood solely and strictly in terms of it being a component in a machinic assemblage (ibid., 140).[220, 221]

Ansell-Pearson attributes this shift to a change in character of Deleuze's Spinozism in its ethological dimension; the ethological 'ethics' of the non-human becoming of the human, that Deleuze now wishes to put into effect in *A Thousand Plateaus*: 'by the time of A Thousand Plateaus, Spinoza's ethology is being deployed to attack the gigantic memory of "man" and to destratify the human organism as a particular kind of stratified organism' (ibid.). Therefore, the concept of autopoiesis may clash with the machinic flow,[222] because it 'stresses the active role played by an organism in its evolution' (ibid., 168), while for machinic thinking,

> all living systems and their boundaries are caught up in machinic assemblages that involve modes of transversal becoming. Although autopoiesis grants a high degree of autonomy to a living system it ultimately posits systems that are entropically and informationally closed (ibid., 170).

This tension was resolved by Guattari in his later work, *Chaosophy* (1995) where he develops the notion of autopoiesis as a machinic one. Ansell-Pearson quotes directly from Guattari: 'The departure from autopoiesis lies in the emphasis placed on its machinic character', which

> introduce(s) into the autopoietic model the necessary disequilibrium and far-from equilibrium conditions required for truly creative model of evolution, in which evolution does not simply involve self-reproduction through the dissipation of outside forces and nullification of dimensions of alterity (ibid.).

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[220] 'A "machinic" approach, then, will not treat machines as projections of the human but rather in terms of "monstrous couplings" involving heterogeneous components that "evolve" in terms of recurrence and communications.' Claims Ansell-Pearson, 141. Further, he stresses, Deleuze and Guattari's *machinic* is devoid of phenomenological desiring as well as of the Marxist machine as a tool external to men. Ibid.

[221] Deleuze and Guattari's concept to go beyond memory and beyond the human, and in direction of rhizomatic modes of becoming (anti-genealogy, anti-memory) in order to resist the autopoietic system of capital, a rhizome is an underground sprout, such as a bulb (which is best thought of as a stem, not a root), in which parts constantly die off in the same measure as the rhizome conceived as a multiplicity rejuvenates itself. It is a subterranean 'network of multiple branching roots and shoots, with no central axis, no unified point of origin, and no given direction of growth' Reminds us Grosz, *Becoming Undone*, 199.

[222] Autopoiesis is a term developed by Guattari separately from Deleuze; however, it is consonant with the mechanism that characterizes *A Thousand Plateaus.* See Ansell-Pearson, *Germinal Life,* 168.

The *machinic phylum* is introduced by Deleuze and Guattari in *A Thousand Plateaus,* as part of their discussion of nomadology and the empire, in the context of technological transferal between the two; the machinic, however, transverses both these categories. 'We may speak of a *machinic Phylum*, or technological lineage, wherever we find *a constellation of singularities, prolongable by certain operations, which converge, and make the operations converge, upon one or several assignable traits of expression*' (Deleuze Gilles 2004 [1980], 448, original emphasis). 'At the limit,' continue Deleuze and Guattari, there is a 'single polygenetic lineage', 'ideally continuous', 'a flow of matter in continuous variation' which is 'as much artificial as natural: it is like the unity of human beings and Nature' (ibid.). This flow, however, cannot be realized as such, because it is cut and divided by *assemblages* defined as 'every constellation of singularities and traits deducted from the flow – selected, organised, stratified' (ibid.). Deleuze and Guattari emphasize the all-encompassing flow: '*The machinic phylum* is materiality, natural or artificial, and both simultaneously; it is matter in movement, in flux, in variation, matter as a conveyor of singularities and traits of expression' (ibid., 451). The concept of the machinic therefore dissolves the notion of a localized and unified entity altogether; what is maintained, though, is the mode of relations between parts that cannot adhere to a unified and central position, subject or another.

The notion of the *umwelt* is now more necessary than ever as a means of embedding and embodying the organisms in a phylum. *Umwelt* is therefore crucial to any process of determination as a means of preventing us from reverting to a universal system. I asked earlier what possible form could *umwelt* assume when we shift from the monad to the nomad? It is here that I see the potential to transpose this concept. I return to the concept of *umwelt* as the key to unlocking these seemingly contradictory terms – on the one hand, the organism-specific autopoiesis processes and, on the other, the machinic flow.

Umwelt is an internalized social/ mental/physical capacity, which leads me to Guattari's *Three Ecologies* (2008 [1989]).[223] Guattari's three ecologies articulate

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[223] It is important to note that Guattari's project is a political one. Peg Rawes brings Guattari's *The Three Ecologies* as a reminder to a forgotten mental aspect as part of a critique

a similar notion to Uexküll's ethological ecosystem, framed from a human perspective, albeit pointing towards a post-human and nomadic subjectivity concept. Guattari's theory entails a nuanced and layered understanding of the concept of environment (ecology) that moves to internalize it, as it includes two modes, a social and a mental environment. These are identified as inseparable from the 'physical' or functional environmental one. In other words, Uexküll's 'soap-bubble' in Guattari's iteration of ecological definition transcends bodily boundaries and crosses between humanist categories known as inside and outside, which can be articulated as a potential structure of a human *umwelt,* which nevertheless does not change the mechanism of relating itself, albeit now the inter-organism outcome is far from equilibrium or harmony.

In the next chapter I show that a focus on human *umwelt*, albeit less centred or ordered than Guattari's, can still be sensitive to other/ non-human ecologies. Whether we should address the relational mechanism in terms of affect, or as Selbach and Loo suggest, in terms of minute perception is a discussion I continue in the next chapter, what I want to take from this current discussion, however, is an emphasis on an embodied organism on the edge of the *machinic*, by denying a boundary line, a skin, and leading to a 'leaky concept' of self. [224] Such a porous embodied position that does not differentiate according to enclosed phyla definitions.

I return to the architectural, biodigital narrative of *emergence* in the context of De Wolf and Holvoet's original definition referred to by the Emtech group (above) that distinguishes between emergence and self-organizing systems on grounds of novelty emitted from the process. I question the production of novelty in these processes if novelty is understood in the context of Deleuze and Guattari as that which defies the deterministic and enclosed processes of evolution which end up producing sameness, versus a process that allows for 'modes of transversal becoming' (Pearson, 171), enabled by porosity to affects

against capitalism's 'homogenizing force' effecting 'commercial architecture, urban and planning relations'. That is 'toxic to subjectivity's biodiversity in all its forms'. Rawes, through Guattari frames these forces as 'bio-powers'. See Peg Rawes, "Architectural ecologies of care" in *Relational Architectural Ecologies,* ed. Peg Rawes (London, New York: Routledge, 2013), 48–9.

[224] The concept 'Leaky' is originally used by Clark, although he refers to the mind: 'The mind is a leaky organ'. See Ansell-Pearson, *Germinal Life,* 171.

that are not predefined. Such sensitivity implies an embodied and transversal understanding of materiality, which is at the same time embodied in a specific *umwelt*. Such a reconceptualization of novelty in biodigital terms allows for unpredictable interactions based on all three ecologies (or more) comprising our subjectivities. Uexküll's contribution therefore is in re-illuminating the importance of a point of view in a process of qualitative differentiation; as such the architectural process cannot include difference for as long as the architect remains on the other side of the object, on the other side of environment.

This complexity is, however, missing from the above-mentioned biodigital computational models, where the environment is always external, tangible and quantified external criteria, tuned in to climate, light, and terrain, understood as universal criteria. In the context of Menges's research, it is the focus on isolated and individual organisms, dissected to bits of disembodied and disembedded data as informing a process derived by GA, which treats 'human' ecology in the same disembodied disembedded universality that denies his projects from qualitative differentiated solution. Such methodology therefore takes *emergence* further away from novelty as a differentiating process. In the next and closing chapter I frame the machinic phylum in the context of digital architecture with data as the material flow that transverses all phyla. This flow of data is nevertheless recognized as a prime resource in our neoliberal social economy; how we differentiate between the two is the focus of my next discussion.

CHAPTER 3 –

TRANSPOSING DIGITAL ARCHITECTURE – TOWARDS A NOMADIC DIGITAL ARTISAN

Introduction

In this chapter I stress the point I make throughout this thesis that multiplicity understood epistemically only, such as in the case of topological mathematical digital methodologies and in the case of biodigital methodologies of emergence still stops short of a nomadic system because the ontological aspect is not being addressed. That is to say that digital mechanisms in architecture rely on a shift to multiplicity, though only epistemically as enabled by the move to digital methodologies. We have not become nomadic, nor would we become nomadic for as long as multiplicity is not understood as a new subject position. It is the aim of this chapter therefore to address nomadic ontologies and to propose thinking about digital architecture with an articulation of a digital nomadic subjects, that is proposing digital subjectivity articulated in nonunitary and affective terms, which requires redefinition of our perceptive faculties and our reliance and bonds in nomadic terms and how they can help to articulate nomadic digital architecture.

Braidotti stresses the creative and ethical aspect of assuming such a project: 'Nomadic political subjectivity defines the political as the gesture that aims at transcending the present state of affairs and empowering creative "counterreactualization" or transformative alternatives' (Braidotti 2011, 32). These are seen in their capacity for an 'accountable recomposition of a missing people' (ibid., 53). 'Neither nostalgia or utopia will do. We rather need to leap forward toward a creative reinvention of life condition, affectivity and figurations for the new kind of subject we have already become' (ibid.).

This project is achieved by cutting 'a more creative path through these discourses in a nondialectical manner', 'by giving priority to the undoing of the dominant model of subjectivity and thus putting on the spot the discourse of the Same, the One' (ibid.). The subject is described as nonunitary, multi-layered, dynamic subject attached to multiple communities (ibid., 35). Undoing identity is a radical process of deterritorialization that entails replacing the modes of relationality as well as the indices of relations:

> Becoming nomadic, by constructing communities where the notion of transience, of passing is acknowledged in a sober secular manner that binds us to multiple 'others' in a vital web of complex interrelations, Kinship systems and social bonding, like flexible citizenship, can be rethought differently and differentially, moving away from blood, earth, and origin of the classical social contract. Given the extent of the transpositions brought about by advanced capitalism and the dislocations of traditional values and social bonding they have triggered, the conditions for renegotiation of our being in this together are timely (ibid., 53).

It becomes clear, therefore, that not-one is a definition of subjectivity that is not confined to the boundaries of a unitary perception of embodiment, because these boundaries are proven already to be violated, either by information technology or by microbiology and should therefore be replaced with bonding definitions and mechanism that transverse them beyond blood/ class/ earth alignments. We are therefore in need of both reconceptualizing the mechanism of relating as well as the criteria according to which one bonds.

In order to overcome the reliance on humanist methods that stem from a unitary understanding of subjectivity, one needs to begin with the faculties of perception and creativity that a human understanding of the world relies on, as a first step towards undoing the reliance on subjectivity understood in terms of identity, that is as constructed and fixed by the empirical reliance on definitions (sex and race, on DNA and blood relations). Rather, opening up the premise of subjectivity to flows of materiality unbound by these static and fixed definitions. The main argument made by Deleuze and Guattari as well as Braidotti, is that these flows of materiality, bounding us to imperceptible forces, are not a new condition, but rather that our current technological state makes these forces no longer possible

to ignore, either because they are now out there in broad day light and moreover, these advances in information and biotechnology accelerate the material and vital make-up of our subjectivity.

The shift from monadology to nomadology in Deleuze and Guattari scholarship, which we saw in the previous chapter, has made their philosophy easily consumed, valorized and universalized in the context of digital architecture. As I showed in cartography 2 part 1, these hybrids are not a case of co-habitation but, rather – they stem from subsuming the post-human, not only in the service of old architectural concepts, but in the service of advanced capitalism's latest mutation – that of neoliberalism.[225] Nevertheless, digital architecture's narratives tell a story of differentiation and novelty, unaccountable for their tangled position. Paradoxically, Deleuze and Guattari themselves describe the forces subsuming of what they call *nomadic sciences* by *state* or *Major Science*, or in their own words: 'nomadic notions such as becoming, heterogeneity, infinitesimal, passage to the limit, continuous variation – be eliminated and civil, static, and *ordinal rules be imposed upon it*' (Deleuze and Guattrai 2004 [1980], 400, my emphasis), as a practice that is not unique to capitalism.[226]

The smooth and the striated have a spatial articulation in Deleuze and Guattari's scholarship, a different kind of mathematics of space, articulate the difference between vectorial, topological space and metric space: in the former 'space is occupied without being counted', while in the latter 'space is counted in order to be occupied' (ibid., 398–9). This general definition has led Deleuze and Guattari to re-evaluate, for example, the difference between Gothic and Romanesque architecture to suggest that the difference resides in the type and methodology of mathematics in use in each period, but not in terms of an evolutionary analysis but, rather, as serving a different ontology. This is also explained as 'opposition, or rather a tension-limit between the two kinds of science – nomad, war machine science and royal, state science' (ibid., 401). According to which, the Gothic is

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[225] See Patricia Clough, "Introduction," to *The Affective Turn; Theorizing the Social,* eds. Patricia Clough et al. (Durham: Duke University Press, 2007), 15–7, where she describes similar socio-political location. See also Beatriz Preciado, "Architecture as a Practice of Biopolitical Disobedience", *Log* 25 (2012): 121–134. Where she tackles the same mutation form a biopolitical stance. See Massumi below for a similar critique.

[226] See Deleuze and Guattari, *A Thousand Plateaus,* 398–404.

seen as a minoritarian practice, which is enabled by generative and material processes. These two ways to account for spatial concepts are not meant as theoretical or historical accounts, but rather as directing various disciplines, including architecture, towards a particular ontology. These alternative accounts allow for a break from the majoritarian scientific traditions of typological taxonomies of the various architectural styles, and move instead to render the processes of their becoming, which account for the way matter is being organized, under what principles and while using what processes. But as we have seen in the examples provided throughout the thesis, it is no longer a matter of the static taking over the fluid, as in the examples given by Deleuze and Guattari in their account of *Nomadology – the War Machine.*[227] Rather, in our current digital age in general and in digital architecture in particular, it is the fluid frameworks that have been colonized and stratified, making untangling an intricate cartography.

This shift is conceptualized by the social theorist Patricia Clough as a paradigm shift from a centralized power model of 'governmentalization of the state' where the state's power to extend its disciplinary practices through institutions such as the church, the school, the prison, the family – models which engage disciplines of representation – is replaced by what Deleuze and Guattari referred to as *societies of control*. While in the old model,

> the nation state explores the way the state moves deeply into the lives of individual subjects through disciplining, through complex strategies of socialization that the institutions of civil society deploy in managing individuals subjected to the moral order (Clough 2007, 19).

The new model's 'target of control' is the production 'of never-ending modulating of moods, capacities, affects and potentialities […] that is to say, in bodies of data and information'. 'Control' therefore is here identified as 'an extension of what Foucault referred to as biopolitics, where the individual body is not so much the focus as the species body and the regularities of the aggregate effect of individual bodies that institute a politics of population' (ibid.). Control has moved to 'work at the molecular level of bodies, at the informational

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[227] Ibid.

substance of matter' (ibid.). The same analysis is made by Braidotti who argues for the mutation of neoliberal societies that obscures and conflates means to differentiate as tools of control, all in the production of value, a point made also by Massumi.[228] This, explains Braidotti, as do Massumi and Clough, is the process by which 'capital shifts its domain of commutation to life itself, *to preindividual bodily capacities, so that value is produced through modulating affect. All of this is inseparable from technoscientific experimentation*'. And so,

> Preindividual bodily capacities are made the site of capital investment for the realization of profit – not only in terms of biotechnology, biomedicalization, and genetics but also in terms of a technologically dispersed education/ training in self actualization and self-control at the preindividual, individual, communal, national, and transnational levels (ibid., 20–1, my emphasis).

The unique situation about our current neoliberal location is therefore the mutating nature of the advanced capitalized machine that does not represent the takeover, but rather absorbs the nomadic differentiating mechanism, seemingly operating under the premise of differentiation. 'Advanced capitalism as globalized cash flow rests on the convergence of information and bio-technologies and activates a proliferation of difference aimed at commercial exploitation' (Braidotti 2006, 263).[229] In the case of digital architecture, topology and complexity/ emergence theories are therefore being immersed in the neoliberal profit machine while qualitative difference is being sidelined.

These examples therefore clarify that 'the image of thought', identified by Deleuze in *Difference and Repetition,* cannot be discarded by simply undoing representation, as suggested by Deleuze in the same work. Amidst these quantitative difference machines, claims Braidotti, the only way to reclaim, is by assuming guerilla-like techniques that work by transposing these stratifications by targeting a position of weakness upon which a transmutation can take place,

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[228] See in Brian Massumi, "Requiem for our Prospective Dead (Toward a participatory Critique of capitalist power)", in *Deleuze and Guattari: new mappings in politics, philosophy, and culture,* ed. Eleanor Kaufman and Kevin Jon Heller Minneapolis: University of Minnesota Press, 1998), p. 57.

[229] See Braidotti, *Transpositions*, 263–7, for a discussion of the commercialization of all aspect of life.

always localized and always embodied,[230] a project begun by Deleuze and Guattari in *A Thousand Plateaus* and continues with Braidotti's feminist nomadic discourse that supplements their non-dualist, non-representational methodologies of post-structuralism, with a post-human politics of location.

> How can qualitative shifts be framed and actualised, in clear dissonance from the pluralistic proliferation of quantified and commodified differences, which is the axiom of advanced capitalism? What forms of ethical and political practices of subjectivity are best suited of the task (Braidotti 2011, 21)?

I have dedicated the previous parts of this thesis to the articulation of the need for a new methodology, to account for these shifts as they unfold in digital architectural practice; it is in this latter part of my thesis that I would like to envisage creative alternatives to the state of the discourse. Nomadic feminist discourse argues for the porosity of these seemingly hermetic categorizations between major and minor sciences and apparatuses and highlights this movement in the 'other' direction, from the minor to the major as hopeful practices of gradual change; these are known as *transpositions*, allowing for nomadic nonunitary reconceptualization as agents of resistance. In this chapter, therefore, I develop strategies to embody nonunitary subjectivities in digital design processes as an alternative to advanced capitalism's techniques of difference elimination. The aim of this chapter is to reincorporate what I already defined through Leibniz and Deleuze as 'points of view' to an articulation of nomadic subjectivities. These are reintroduced into the making of digital architecture through alternative affective and nonunitary practices of data following, to reclaim the forgotten/ missing bodies of digital discourse.

Each nonunitary subject expresses these flows according to her/his capacity to affect and be affected. This is to say that the discussion should no longer be seen framed by the binary *autopoietic/ machinic* but rather, it should articulate the means of engagement of this nonunitary subjectivity with the flows of digital environment. This therefore means a dual articulation of umwelt as well as the

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[230] Braidotti repeats this analysis in a number of places. See Braidotti's lecture at Central St Mertins; "Vectors of Affirmation", last accessed March 2015. http://backdoorbroadcasting.net/archive/audio/2015_03_10/2015_03_10_Rosi_Braidetto_talk.mp3.

flow. In other words, this chapter unfolds a discussion of how nonunitary subjectivity engages with the flow and what the flow consists of, both in general terms and in the context of digital architecture.

This chapter is constructed in two parts. The first part looks at existing articulations of resistance and critique of digital practices in architecture, mainly existing critique of its compliance with neoliberalism and the lack of ethical position through three prisms, discursive, theoretical-technical and practical. The first prism looks at the premise of critique forming over the past five years in architecture scholarship around ethical and political issues. The second prism is a theoretical critique of digital data capacity to articulate novelty, and the third prism of critique is in the form of an experimental architectural digital project.

The first prism is a short literature review of current publications expressing a critical stand in relation to digital production, both parametric and biodigital, discussing the main themes and methodologies addressing critique, articulating the need for channelling critique while assuming nomadic position. The second prism draws on Luciana Parisi's account of the algorithm as data – materiality, where I highlight the danger in blurring the ethical aspect of architecture when assuming a disembodied new materialist position towards data. The third prism examines an example of a redefinition of digital project, where digital materiality and subjectivity are challenged, discussing François Roche and Stephanie Lavaux's *I have heard about …* project (2004–06) as an example of a non-representational, post-humanist and embodied 'data collection' process in digital architecture that is nevertheless limited in its understanding of perception.

The second part is a transposition of digital discourse to a nonunitary premise, Where I first theorizes nonunitary subjectivity and its modes of articulation, especially the nonunitary alternative conception of memory, time and affect. Here I look at how memory as a transversal and empowering tool can defy physical and temporal boundaries and redefines our alliances. I then expand on affect, to discuss how the concept of affect advances the enfleshment of the nomadic subject in relation to data, as it allows me to locate the subject's methodology of perception. Affect sheds light on the Leibnizian modes of

perception I examined earlier, particularly in relation to the role of what is commonly known as the non-conscious in the determination of singularities.[231] I will then look at two figurations of such nonunitary subjectivity; figuration is understood away from *figure,* defined by Braidotti as creative alternative to critique. 'A figuration is a living map, a transformative account of the self – it [i]s no metaphor. It fulfils the purpose of finding suitable situated locations to make the difference between different locations' (Braidotti 2011, 14). The first discusses Ada Lovelace's extraordinary affective capacity, also defined as 'scattered brains', a figuration of nonunitary subjectivity that supports molecular perspectives as a way of relating to data. The second figuration, the *digital artisan*, concludes this thesis with. This is the final figuration in resisting and reclaiming a nomadic, minor perception of novelty as stemming from an ethical differentiation process – the *digital artisan* as the embodiment of the nomadic apparatus in architecture.

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[231] I am cautious when using the tern *unconscious* because of the term's subsumption by psychoanalysis, where it relates to lack. Nomadic relationality bypasses dialectics, hence *non-conscious* as a means to dissolve the hierarchy implied in the dialectic. I refer here to Deleuze who explains: This is completely different from conceiving an unconscious that expresses differentials of consciousness or conceiving an unconscious that expresses a force that is opposed to consciousness and that enters into conflict with it. In other words, for Leibniz, there is a relationship between consciousness and the unconscious, a relation of difference to vanishing differences, whereas for Freud, there is a relation of opposition of forces'. See Deleuze, *Vincennes Sessions, Leibniz Seminar*, 29 April 1980.

Part 1 – where are we at? Positioning current political, ethical critique

Figure 59 (left): Mathhew Poole and Manuel Shvartberg, The Politics of Parametrcism; Digital Technologies in Architecture , 2015, book cover image
Figure 60 (right): Luciana Parisi, Contagious Architecture, 2013, book cover image

Figure 61 (left): The Forgeting of the Ethics of Immanence, Hélène Frichot, 2012, Architectural Theory Review on-line magazine.
Figure 62 (right): Log 25, Reclaim Resi[lience]stance//.....R2, guest-edited by François Roche, 2012, magazine Cover image

Political dualist critique

The 'end of history' phase of intellectual thought that I refer to in chapter 1 set the discourse's tone and the tendency towards a disembodied new materiality. This is a tendency that renders the socio-political sphere inapplicable to digital practice in architecture. One of the most vocal advocates of a non-political digital architecture is Patrik Schumacher, who claims that 'implicit affirmation is necessary condition of professional engagement with social reality' and more 'The currently fashionable concept of a "critical" or "political" architecture as a supposed form of political activism must be repudiated as an implausible phantom' (Schumacher 2015, 20.I). It is no surprise, therefore, that two decades have passed before an articulation of digital architecture that questions this complicity with neoliberal agendas has emerged.

A politically critical literature theorizing digital architecture therefore did not appear until the 2010s and in tandem with global social unrest that inspired, for example, the publication of *Log (25)*, guest-edited by François Roche, issued in the heyday of the Occupy movement (summer 2012), framed by a call to activism and voicing a variety of angles, from Marxist (Negri) to feminist (Preciado). In the introduction to the publication *Reclaim Resi[lience]stance//……R²*, which takes a militant tone against the economic world order and against architecture's compliance with it, Roche is reflective about the ways to traverse these hegemonies:

> Log 25 explores ways to navigate this antagonism, which could be negotiated in an (uncertain) and ambiguous manner … non-hierarchical, nondeterministic, defining a path in which *architectural protocols* could fuse bottom-up and top-down, contingently, simultaneously, as if the ingredients were making recipes, and the recipes were modifying the substance of the ingredients … apparatuses of exchange, which transform the game power and the knowledge diffused through that game (Roche 2012, 2, original emphasis).

In the same issue of *Log 25*, Beatriz Preciado warns us against the danger in our neoliberal or advanced-capitalist age, in which we have departed from a biopolitical regime of disciplinary bodily control through centralized bodies and architecture (the school, the church, the hospital, the prison) to a molecular,

cellular undercurrent stratification of bodies for the sake of commodification as the new control mechanism. This cuts across the humanist categories: 'organism and machine, nature and culture, are obsolete disciplinary fictions' (Preciado 2012, 127).[232]

2015 saw the first publication to specifically and comprehensively address the politics of parametricism (*The Politics of Parametricism* 2015). The overall tone is that of frustration in relation to the ease by which current digital practices align with neoliberal practices that prevent it from adequately addressing socio-economical concerns. This publication is an important addition to the introverted tendencies shown by the discourse and the usual self-referentiality and somehow incestuous world of parametric-related publications. The book targets the following agenda: 'to capture how the current politics of parametricism was *and* is cultivated – and how it could and *should* be different' (Poole and Shvartzberg 2015, 9–14). This collection of essays adds an important dimension to the overly formalistic/ technical literature concerning this field and manifests a wide swathe of approaches and methodologies, all of which, by nature of this publication, are critical of the current state of affairs. However, and following my call for the revival of ontological questions as a critical yet affirmative means to deal with the above-described mutation, I would argue that the theoretical framework dealing with parametricism throughout the book is still modernist and applies dualist methodologies and apparatuses. Although it raises awareness of the political, it still ends up with limited results. When introducing their definition of the 'political', the editors include a wide range of political approaches and definitions, from Enlightenment thinkers through to the Frankfurt school and on to neo-Marxist thinkers and the post-structuralists, while omitting feminist discourse from their historicity altogether. This lack, however, is compensated for by two papers that manifest alternative methodologies: the above-mentioned Christina Cogdell's *Breeding Ideology: Parametricism and Biological Architecture,* (referred to in cartography 2, part 2),

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[232] See also "Pharmacopornography: An Interview with Beatriz Preciado," last accessed July 2015. http://www.theparisreview.org/blog/2013/12/04/pharmacopornography-an-interview-with-beatriz-preciado/.

and Peg Rawes's *Spinoza's Geometric and Ecological Ratios*, which I refer to in this chapter as an example of an embodied and embedded relationality that leads in the direction of ethical practice, suggested as an alternative to the hegemonic role of parametricism. Rawes critiques the exclusion of economical and sociological parameters from parametricism's prevalent ecological discussion, and asks, 'Is parametricism of any real value for aiding the design of non-pathological, ecologically responsible buildings, which require ratios of ethical, economic and material intelligence, rather than myths of emergence?' (Rawes 2015, 214). Rawes draws on a Spinozist conceptualization of 'wellbeing' developed through his notion of *ratio,* as an example to a rational (geometric) thought that is also ecological and relational, to suggest the incorporation of these lost criteria into architectural practice (though not specifically into parametric architecture). Spinoza's seventeenth century definition of geometric thinking, argues Rawes, challenges advanced capitalist thinking of subjectivity and materiality by proposing a pre-modern affectual and relational alternative subjectivity concept. Such alternative subject sensitivity, argue Rawes, is inclusive of what Guattari defines as the subject's *three ecologies* (environmental, social and emotional). Rawes shows how current feminist theory (Braidotti, Haraway and Grosz), as well as Guattari's expansion of the concept of subjectivity understood in terms of zoe can open up the architectural discussion to ethical considerations.[233] I share Rawes critique of parametricism as well as her affirmative, embodied reconceptualisation of subjectivity, although I defer in my figuration of such subjectivity and in my methodology.

Another feminist critical voice from the same period is Hélène Frichot; in her paper *The Forgetting of the Ethics of Immanence* (2012), Frichot reminds us of the openness of Deleuze's concepts and expresses caution in relation to architectural practices of 'applying' its mathematics without considering his *ethics of immanence.* Her understanding of immanence and ethics in the context of digital architecture refers to a general notion of openness that should not be entirely harnessed to the rational machine, and to a repositioning of subjectivity;

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[233] See Peg Rawes, "Spinoza's Geometric and ecological ratios", in Matthew Poole et al., ed., *The Politics of Parametricism: Digital Technologies in Architecture* (London: Bloomsbury, 2015), 221–7.

an ethics of immanence allows for radical transformations of subjective
agency, displaces vertical hierarchies for horizontal networks, calls for
immediate rather than deferred action, and acts in response to contingent
problems without deferring to a greater or transcendent authority. In
addition, an ethics of immanence pertains to our capacity to affect and be
affected (Frichot 2012, 28–9).[234]

Frichot begins an important discussion in regards to the misapplication of
Deleuze to digital processes and although lacking on ground of methodologies,
she nevertheless opens up an important path to a creative and politically aware
conversation by repositing immanence as an ethical discourse. Her specific
critique is formed towards biodigital architecture when she argues: 'With the
rise of the aesthetics of emergence', known as the 'biotechnological paradigm',
'which also includes the enduring legacy of Deleuze's philosophy (both explicitly
and implicitly), what tends to be forgotten is the importance of framing ethical
questions and developing an ethical expertise, for instance, in the midst of the
design act' (ibid., 29)*.* Biodigital discourse relies on other complex sources for its
models. I nevertheless share the overall sentiment expressed by Frichot.

In cartography 2, part 1, I discussed the legacy of *folding* in highlighting
continuity as the main topological machine of difference, and the seductiveness
of *folding* as its formal manifestation, despite a far more nuanced understanding
of the Deleuzian ontology by Greg Lynn, Peter Eisenman and Jeffery Kipnis.
Nevertheless, the digital narrative that was consolidated in the first decade of the
2000s does not reflect this nuanced approach to topology as a post-humanist
differentiating approach. With the availability of digital tools, the ethos of
novelty that crossed over to the age of the algorithm maintained humanist/ post-
humanist hybridity, applying Deleuzian theories of immanence to a
predominantly humanist ontology. I have also shown how Deleuze's *The Fold* is
partially and inadvertently responsible for this interpretation. *Emergence*, on the
other hand, and contrary to the way in which it is presented in Frichot's text – is
not a concept stemming from the philosophy of Deleuze and Guattari, but from

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[234] Frichot draws on the following Deleuze and Guattari's sources for her
conceptualization of *immanence:* 'Deleuze and Guattari's approach to such an ethics can be traced
through a genealogy of their most recognisable concepts, including the Body without Organs
(borrowed from Antonin Artaud), the rhizome (a botanical metaphor), and becoming.'

complexity theory in computation and mathematics, as shown in cartography 2, part 2. Therefore, we cannot argue that a Deleuzian concept has been *forgotten* in this context. We can nevertheless point to an overall tendency by digital discourse to articulate complex epistemologies and material self-governing processes predominantly as tools of control, that harness the nomadic flows allowing their very methodologies (folding/ complexity/ emergence) into the above-mentioned advanced capitalism *mutation machine* which exploits these epistemic concepts of novelty for profit making. From this standpoint, letting go of the *ethics of immanenc*e is not the result of an act of forgetting but of a deliberate omission of nomadic, feminist and embodied practices from digital discourse. Frichot's important stand is in articulating the possibilities of digital architecture to incorporate ethical stand if immanence is understood in its capacity to transform subjectivity patterns and affective discourse, although not entirely clear what is the correspondence between the two, it s nevertheless another example to highlighting of an ontological aspect missing from the discourse, which holds the capacity to transform the discourse towards ethical grounds.

These two last examples are important reminders of the ethical consequences of a disembodied digital practice and how the discourse can benefit from alternative, relational and affective definitions of subjectivity. In the closing part of this thesis I develop a post-human subjectivity figuration that is affective and relational, as well as nonunitary and nomadic, immersed in the materiality of digital architecture, in data. In the coming discussion I show why nonunitary reconceptualisation of subjectivity can transpose the digital practice to an ethical realm, but before I do, I discuss two other critical approaches to the digital discourse that focus on data as a source of novelty.

Disembodies material flows – random data

Another important critique of digital discourse comes in the form of a book entitled *contagious architecture* (2013) by Luciana Parisi. [235] Parisi's critique is

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[235] 'Luciana Parisi is Reader in Cultural Theory, Chair of the PhD programme at the Centre for Cultural Studies, and co-director of the Digital Culture Unit, Goldsmiths University of London. 'Her research draws on continental philosophy to investigate ontological and epistemological transformations driven by the function of technology in culture, aesthetics and

important because it emphasizes the digital realm itself as a materiality, which its flows is greater than the attempts to reduce it to finite axioms, to mathematical constructions.

> This book is about the logic of computation and its ingression into culture. It describes a world in which algorithms are no longer or are not simply instructions to be performed, but have become performing entities: actualized that selects, evaluate, transform, and produce data. In this world, algorithms construct the digital spatiotemporalities that program architectural forms and urban infrastructures, and are thereby modes of living [...] a closer look at algorithmic procedures shows that incompleteness in axiomatics is at the core of computation. *These performing entities – algorithms – expose the internal inconsistencies of the rational system of governance, inconsistencies that correspond to the proliferation of increasingly random data within it* (Parisi 2013, ix, my emphais).

The contribution of Parisi is therefore in the affirmation of the algorithm in itself, as part of a computational post-cybernetic world, where the content of architecture is a transient factor that does not construct the virtualities and actualities of its determination, but rather enumerates it temporarily before moving forward. Parisi positions her stand as a critique on constructivist analysis of the algorithm as a cultural/ textual construction, while claiming that 'overlooking the existence of actual entities that cannot be physically felt or cognized, the cultural approach to cybernetics and computation has thus dissolved the reality of algorithms into thin air' – an approach, Parisi claims, that has resulted in the algorithm being a finite set of rules, which steals any chance of novelty. 'Algorithmic objects are not simply emergent forms within software, but are discrete unities injected with random data' (ibid.). Algorithms here are described as being violated pieces of data. There was intent to control, but the operation of the algorithm – namely, their reliance on vast amounts of information – means that some of the data cannot be processed, rendering them incomputable.

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politics. Her writing aims to develop a naturalistic approach to thinking and technology. She is interested in cybernetics, information theory and computation, complexity and evolutionary theories. Her writing addresses the technocapitalist investment in artificial intelligence, biotechnology, nanotechnology.' See "Goldsmiths University website", last accessed 20 November 2016. http://www.gold.ac.uk/cultural-studies/staff/l-parisi/.

Parisi's argument stems from the interface between data and the computational world in general, maintaining that once meshed with the digital world, the topological model no longer realizes the differential relations between parameters extrinsic to the system in the production of variability. The reason for this is that such a model does not exhaust all relations. Here Parisi refers to the relations within the algorithmic sequencing, clarifying her stand that the quantification of data as parameters cannot be assumed to simply become part of the continuity because such a model neglects the discrete parts that are not being subsumed into a whole, discrete elements that are not computable but are nevertheless part of the topological relationality. We saw earlier that the reason for the unattainability of the infinitesimal in parametrics is the introduction of the non-standard analysis. However, Parisi illuminates the dark parts of the virtuality of digitality by pointing to singularities that escape calculation, random pieces of data that are allowed free roaming as the key to the system's novelty while reworking Chaitin's digital theory. Accordingly, 'Chaitin's view though is that the infinitesimal is located at the discrete points in themselves and not in the relations between two points.' In relation to digital architecture Parisi adds; 'Chaitin's theory suggests that each and any object is at once discrete (and indivisible) and yet composed of infinite uncountable parts. It is precisely this notion of incomplete yet discrete quantities that can transform algorithmic architecture into a metamodel of immanent signs and object' (ibid., 42–3).[236]

Parisi's theory operates to transpose topology as a system of control, control being defined here in relation to the software responding to real flows of data from the environment arguing that parametricism, far from controlling the spatiotemporalities, is instead 'unleashing random events or unlived worlds in urban design' (ibid., 171). This condition, claims Parisi, is intrinsic to

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[236] It is important to locate Parisi's theory with Whitehead's mereotopology model: 'A mereotopology of atomic spatio-temporality instead explains that potentials break the continuity of connection. According to Whitehead, Leibniz's infinitesimal divisions, which Poincaré defined as topological invariants, could not explain the reality of events on the plane of continuity (or the continual chain of cause and effect determining the sequential relations between actualities), because the distance between actualities could not be filled by the infinitesimal continuity of percept and affects (Whitehead, 1978: 332–3). On the contrary, the distance between actual entities had to be considered as such: a space of connection, overlapping, inclusion, juxtaposition, disjunction and intersection defined by the points and lines of finite actualities. In other words, there are always actualities amid actualities.' See Parisi, 181.

computation, irrespective of the interaction between software and hardware, but the overwhelming state of unprocessed data, or *incomputable data*, has become a digital condition.

Parisi makes a point of clarifying that she rejects both the mathematical assumption according to which everything is calculable, and the notion that a finite set of rules can not only describe but also predict the biophysical environment. At the same time, she rejects the phenomenological model, or metamodel, according to which everything is experienced and therefore architectural evolution should be a result of feedback, interactions and environmental input. For example, when referring to a responsive wall project (Hypebody's interactive wall) Parisi claims that 'what is missing from these interactive projects is an engagement with the algorithmic nature of spatiotemporal experience' (ibid., 25). 'Here the algorithmic programming of spatiotemporalities has entered the space of atomic structures so as to grow systems that anticipate the conditions of possible responses' (ibid., 24). As an alternative, Parisi is in pursuit of a data-collection methodology that is not reliant on the biophysical environment of feedback – data collected from materials designed at the 'atomic and nano levels' (ibid., 24). Novelty in such a system, argues Parisi, emerges through an encounter with incomputable data that corresponds neither to the mathematical nor to physical input.

> If digital computation has come to characterise the invisible architecture of everyday space, *the pervasive extension of algorithmic logic has now become attuned to alien regions of perception and cognition.* These are zones occupied by abstract yet real incomputable states that interfere with computational calculus by anticipating new conditions of spatiotemporal experience (ibid., my emphasis).

I would like to point to two areas of disagreement I have with Parisi's theory, the first is in relation to her overall analysis; for I agree that data should be our new frontier in resisting the axiomatics of the mutated differential calculus, however, my concern with such an immanent yet categorical condition of incomputable data is that it brings us back to the realm of essentials, static definitions, which creates another universality that operates as the dialectic of control, and as such nullifies its effect in the sense that this solution does not escape the image of

thought, but rather negates it. My second point of disagreement is on Parisi's affectual model; for I agree that novelty comes from encounters with the atomic and nano level of data, I nevertheless argue that such affectual model is in fact affectual *because* it is embodied (I develop this argument below). That is to say that where I draw apart from Parisi's analysis is in her implicit assertion that the human is external to this flow, to data – a category apart, standing in the way of novelty, which leads to her assertion that only the incomputable may lead to novelty, as such, it is only the algorithm that holds an affectual capacity. I argue that Parisi, in her eagerness to omit from the possibility of novelty any semblance of socially constructed subjectivity has nullifies the system altogether by denying it any potential of embodiment and with it the socio-political and ethical significance of this discipline. Novelty will not emerge as a result of an anticipating conscious and feeling subject, but rather than evacuating the system from any human input and proceeding to nihilist randomness, I suggest to relate novelty to relational and affective posthuman engagement.

Parisi's contribution to my thesis is therefore limited to the articulation of data in its capacity to flow beyond the programmable, in recognizing data as the matter itself, digital matter. However, it is time to consider an embodied data alternative. I now turn to explore a different model of engaging with data following, that of affect as it unfolds in François Roche and R&sei 2004 project– *I've heard about …*

Embodied data following

Figure 63: R&Sie, I have heard about ... 2004

Rumours

I've heard about something that builds up only through multiple, heterogeneous and contradictory scenarios, something that rejects even the idea of a possible prediction about its form of growth or future typology.

Something shapeless grafted onto existing tissue, something that needs no vanishing point to justify itself but instead welcomes a quivering existence immersed in a real-time vibratory state, here and now.

Tangled, intertwined, it seems to be a city, or rather a fragment of a city.

Its inhabitants are **immunized** because they are both vectors and protectors of this complexity.

The multiplicity of its interwoven experiences and forms is matched by the apparent simplicity of its mechanisms.

The **urban form** no longer depends on the arbitrary decisions or control over its emergence exercised by a few, but rather the ensemble of its individual contingencies. It simultaneously subsumes premises, consequences and the ensemble of induced perturbations, in a ceaseless interaction. Its **laws** are consubstantial with the place itself, with no work of memory.

Many different **stimuli have** contributed to the emergence of "I've heard about," and they are continually reloaded. Its existence is inextricably linked to the end of the grand narratives, the objective recognition of climatic changes, a suspicion of all morality (even ecological), to the vibration of social phenomena and the urgent need to renew the democratic mechanisms. **Fiction** is its reality principle: What you have before your eyes conforms to the truth of the urban condition of "I've heard about".

What moral law or **social contract** could extract us from this reality, prevent us from living there or protect us from it? No, the residence protocol of "I've heard about" cannot cancel the risk of being in this world. The inhabitants draw sustenance from the present, with no time lag. The form of the territorial structure draws its sustenance directly from the present time..

"I've heard about" also arises from anguishes and anxieties. It's not a shelter against threats or an insulated, isolated place, but remains open to all transactions. It is a **zone of emancipation**, produced so that we can keep the origins of its founding act eternally alive, so that we can always live with and re-experience that beginning.

Made of invaginations and knotted geometries, life forms are embedded within it. Its **growth** is artificial and synthetic, owing nothing to chaos and the formlessness of nature. It is based on very real processes that generate the raw materials and operating modes of its evolution.

The public sphere is everywhere, like a pulsating organism driven by postulates that are mutually contradictory and nonetheless true. The rumours and scenarios that carry the seeds of its future mutations negotiate with the vibratory time of new territories.

It is impossible to name all the elements "I've heard about" comprises or to perceive it in its totality, because it belongs to **the many, the multitude**. Only fragments can be extracted from it.

The world is terrifying when it's intelligible, when it clings to some semblance of predictability, when it seeks to preserve a false coherence. In **"**I've heard about," it is what is not there that defines it, that guarantees its readability, its social and territorial fragility and its indetermination.

Figure 64 I have Heard About manifesto

I have heard about … by New Territories (2004)[237, 238] is a project defined as 'an organism', a 'biostructure […] not only receptive to human vicissitudes, it is their nerve ending' (Roche 2004–06, 1.1.1). It is a habitat that grows according to the needs and feelings of its inhabitants, known as 'Bio-citizens' (ibid., 2), constructed and expanded by robotic arms known as Viab.[239] The Viab operates on the basis of an open-source script, each Viab being equipped with 'identical original script, yet each open to data input', 'with the desirable result being: The resulting form is uncertain and even unpredictable.' The script is 'permeable' to two types of input: representational, in the form of 'expressions of individuality, relational, conflictual and transactional modes, etc', 'but also to the most discrete data such as the chemical emissions of those who inhabit it' (ibid., 1.4). It has a clear political aim in mind: 'its fabrication cannot be delegated to a political power that would deny its exchange procedures and design its contours in advance' further, it is described as 'the political antidote to the anticipatory modes that make space a system of control'. The inhabitants are referred to as *citizens* who give their consent to take part in a 'particular social body so as to share physiological information'. Open source is defined as being 'a political and geographic tool' (ibid., 5.0).

I now outline this project's methodology, mechanism and components:

The robots' decision-making process is negotiated by the algorithm's interaction with data that comes from dual sources, also referred to as internal and external sources. This is explained as follows:

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[237] François Roche's (previously with Stephanie Lavaux until 2011) practice *New Territories*, or in its old name R&Sie (pronounced *heresy*) was founded in 1993 in Paris. Their work was featured in 2003–04 *Non Standard Architecture* at the Pompidou Centre, Paris, curated by Frédéric Migayrou, see chapter 1. A retrospective of their work is currently showing (March 2017) at the FRAC institute, Orléans among other places. See http://www.new-territories.com/roche%20cv.htm (last accessed January 2016) for an extended biography.

[238] The following description is based on *New territories* website. See "New territories", last accessed November 2016. http://www.new-territories.com/polemiquearchiart.htm.

[239] Viab: "(Contraction of variability-viability) -1A. A reactive and autonomous construction machine employing secretion. Developed for the first biostructure in 2005, the Viab launches a robotic algorithm that allows it to build architectural structures based on the principles of indeterminacy. Its open source programming makes it permeable to external inputs. Its basic script defines protocols for action, movement and all sorts of constraints, but also entirely integrates environmental variables that could affect its primary function The Viab is localized. The supply of energy and raw materials (powder, water), or in other words the process of extraction and transformation, directly depends on the biostructure's environment".

The construction algorithm responds to two kinds of data inputs, internal and external. The external inputs comprise the pre-existing urban morphology, modes of accessibility, structural limits, available natural light, the dimension and thickness of the habitable cells, the ensemble of parameters of the local biotope, etc. The internal inputs are of two types: 1) Chemical: physiological empathy, endocrinal secretions, bodily emissions, prepsychisms. See [Self-alienation].2) Electronic: individualisms, personal commitments, subjectivities (information and decision-making network) (ibid.).

The chemical input is received via receptors, while the *electronic* input refers to deliberate changes in the script by the occupiers of the habitat, which are 'valid as long as these rhizomes do not overturn any general principles'.[240] The chemical component is an involuntary process which works as a filter to requests for change to the script: 'Citizens of the biosphere agree that their requests (for growth, transformation, repairs, etc.) be submitted to the influence of the chemical stimuli of the multitude' (ibid., 2.1). The chemical reaction is monitored via nanoreceptors.

Nanoreceptors, […] –1. Nanoparticles (NP) used to capture and detect the presence of a chemical substance in a particular atmosphere. –2A. Nanoreceptors can be inhaled, making it possible to 'sniff' the chemical state of the human body. –2B. Functioning: Like pollens, they are concentrated in the bronchia and attach themselves to the blood vessels. This location makes it possible for them to detect traces of stress hormones (hydrocortisone) carried by the hemoglobin. As soon as they come into contact with this substance, the phospholipidic membrane of the NP dissolves and releases several molecules, including formaldehyde (H_2CO) in a gaseous state. The molecules rejected by the respiratory tract are detected using cavity ring-down spectroscopy (C.R.D.S.). This is a method of optical analysis using laser beams programmed to a particular frequency, making it possible to measure the density of air-borne

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[240] The units are developed according to the following rules: 6.2 A new citizen may adopt one of two residence modes: - "Entropic", which consists of negotiating growth with the structure. - Nomadic, which consists of borrowing an abandoned cell. In both cases, the *Viab* is to carry out the transformations. 6.4 All citizens are obligated to develop a three-storey habitable space comprising an underground cellar and an attic above the ground floor, no matter how small. Flat, single-storey residences are prohibited. This is a general rule. 6.6 Citizens are completely free to modify, transform or adapt this initial envelope or even to solidify it with the material of their choice. Note that only vertical walls are permanent. The *Viab* can modify and perforate horizontal structures (ceilings and floors). 6.7 Any use of these cells is allowed, for private or public use or services." See ibid.

molecules. The wavelength used for the detection of formaldehyde is around 350 nanometers. -3. Consequently, the nanoreceptors keep the *Viabs* informed about the ambient stress level (ibid., processes).

The chemical data remains anonymous.[241] 'The induced behaviour is comparable to a kind of collective intelligence called swarm intelligence.'

> Swarm intelligence. Term designating a form of behaviour characterized by the absence of central control or overall architecture. On the basis of simple rules for individual behaviour, swarm intelligence makes it possible, for example, to understand and simulate cloud phenomena, i.e. the behaviour of bunches of individuals in movement that are reactive to obstacles and avoid all collisions, whether between individuals or with the geographic features through which they travel (ibid.).

The approach to the site is as follows:

> The biostructure expands without eradicating the pre-existing tissues. The process does not start from a tabula rasa, nor does it lead to patrimonialization. The structure behaves likes a graft, or better said, a parasite. It operates in previously urbanized zones, seeps into interstices, places and environments, etc (ibid.).
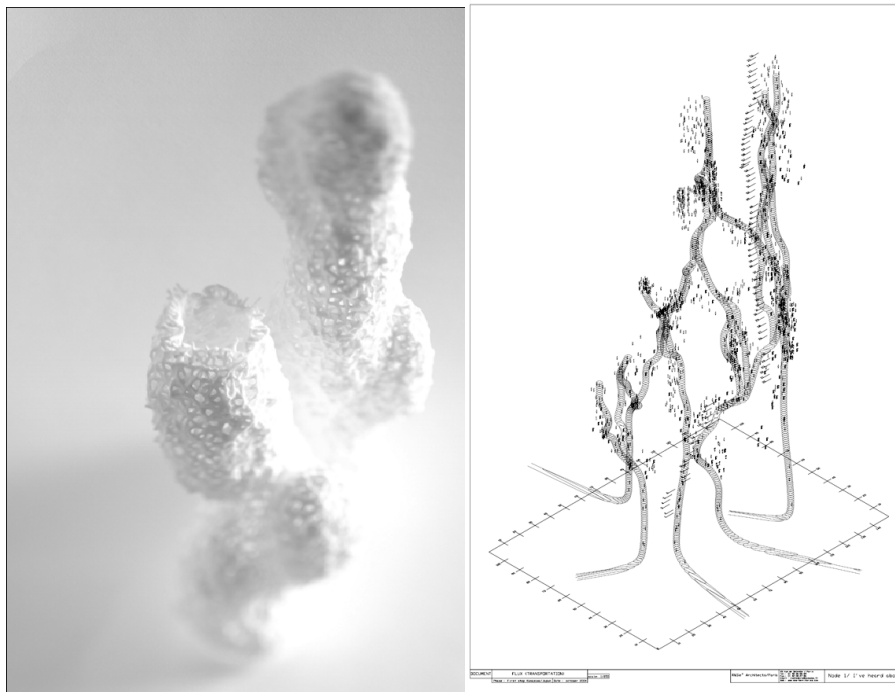
Figure 65 (left): Structural Study
Figure 66 (right): Indoor envelope analysis

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[241] See Roche 2006, 3.2.2

Figure 67: Mass Plan

articulation
Regular pneumatic tentacle joints

joint without pneus

enlarged joints

compressed joint

1   tube for concrete transport
    (flexible and compressible)
2   tube for compressed air
    transport (flexible)
3   electronic cable
4   electronical valves to control
    air pressure in pneus
5   back pulling steel cable, con-
    necting top with bottom of
    the tentacle to shorten the joints,
    in order make the whole tentacle
    fit into the viab's interior body
6   spacer to limit deplacement
    of tubes and cables
7   the joint's skeleton
8   vertical hole to enable com-
    pression and 90° turns
9   pair of antipotical pneus

bended joint

Figure 68: Viab regular pneumatic tentacle joints

It is not so much the production, the use of a robotic arm for concrete injection that was ground breaking at the time, that I define as experimental, but rather it is the open-ended design methodology and the agents it synchronizes. A second aspect is the socio-political vision this process unfolds.

Compared to the superficial understanding of open-source processes I have discussed in cartography 1, narrative 2, the 2007 *scripted by purpose* exhibition as well as in relation to Mario Carpo's disenchantment with open source expressed in the epilogue to *The Alphabet and the Algorithm*, Roche incorporates open-source algorithm into a design process that willingly shares control. Roche's mechanism is open to contingencies not intended by the designer and is porous to data input from representational as well as imperceptible sources. It is this tuning-in to data understood as external and internal to the *citizen* that relies on and enacts *umwelt* or, in its humanist-oriented version, the three ecologies, in a clear attempt to escape the prescription of the architectural state apparatus and its bearing on the process as an external entity to the living. This ambition of escaping the grid – the biodig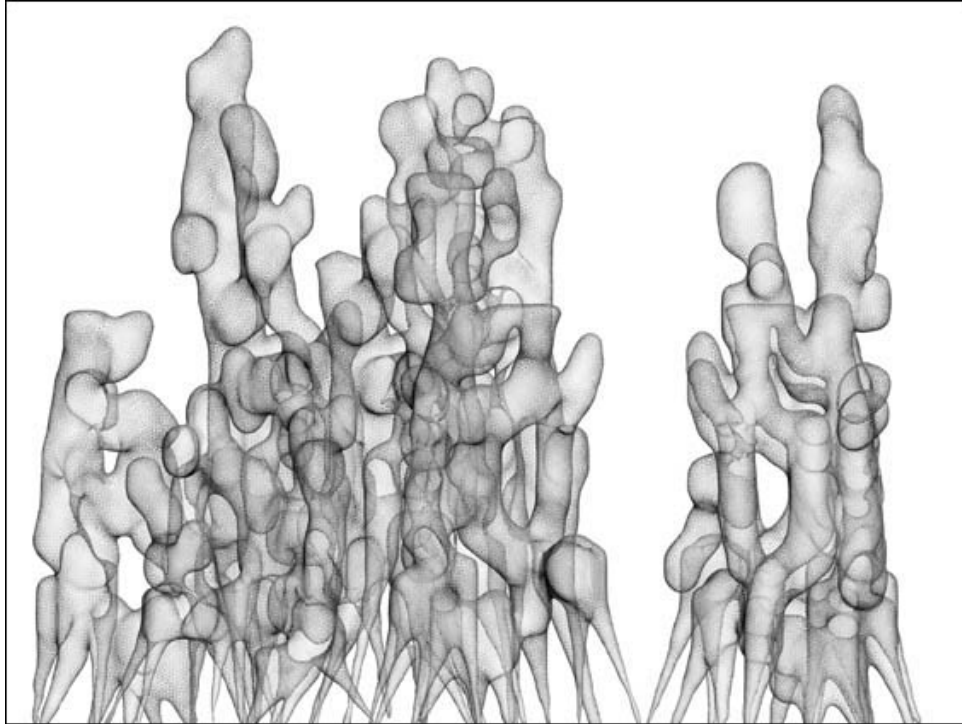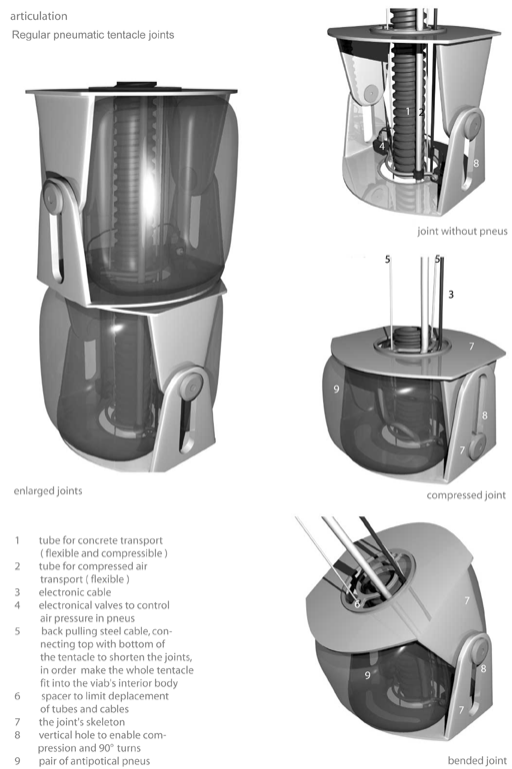ital grid and its reliance on the neutral and the universalist – is extended by imagining this habitat as self-sustaining in terms of energy and food production.

It is the subject position that emerges from this process that I find problematic because of the hierarchy still implied between the 'state apparatus' finding its way in with the structural parameters, but mainly, it is the subjection of the affectual to a sub-layer; rather than the affectual forging the design itself, it is relegated to a mechanism of consent or opposition to design decisions taken in a 'representational' mode. Another point, which I find problematic is limiting of the affectual to what can be emitted and measured by one mechanism (nanoreceptors) with the aim of emulating swarm intelligence. I find the need to mimic non-human intelligence unnecessary in this case because the process itself – that of tracing anxiety levels in response to a given spatial situation – bypasses some of the humanist tools that separate cognition from an enfleshed material and reconnects it to the body. For a fuller register of bodily capacities in terms of affective process, a way forward would be for the non-representational input, the affective, to influence the design and not only its reception. Also, it is

the affective spectrum that the design process opens up to that should be increased. Registering a chemical reaction to anxiety is shutting down on so many other layers of expression and experience of which our bodies are capable, not to mention how close it gets to royal science in the sense that this register is perceived as neutral.

Therefore, one way forward would be to relocate the proposition of *I've heard about …* away from the physiological, the emotional, the primal, and bring the embodied experience to encompass other data. I would like to propose compensating this embodied and embedded element with another alternative digital data input that does not seek to be accurate or true, or abstract, but on the contrary, seeks to become as inclusive and as messy as possible as well as relying on potentiality, incomplete and broken pieces of subjectivity, the stuff memories are made of, this is the way towards an embodied reclaiming of the design process that is nevertheless a nonunitary embodiment.[242]

It is the limited understanding of affect that comes up from the way the internal input is designed that I would like to expand on, for it is here that I see the possibility of developing an alternative data flow that will correspond to my understanding of embodied and embedded nonunitary subjectivity. This best corresponds to an understanding of affectual relationship in a different corporal dimension, one that requires awakening or rather consciousness levels that cannot come to the fore with hypnosis or any simulation of the state of hypnosis, which, as explained by Roche, facilitated the data flow that comes from chemical reaction. Nor is affect an emotion, or a derivative of emotion – the two are not interchangeable. While affect relies on emotions, emotions in themselves cannot encapsulate the span of experiences and times that our bodies are capable of, as I discuss below.

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[242] I would like to point to a few other less clear aspects of this project that are nevertheless secondary to my discussion – at no point along the elaborate and manifesto/contract-like design 'protocol' is there any mention of the parameters that the algorithm is based upon and the correlation between the input and the output; in other words, what dictates the formal overall structure, what are the degrees of freedom, the areas of nondetrmination, of openendness? What is the relationship between the open script and the two types of input (the chemical and electronic)? What are the levels of change in the script? What are the constants? It is not entirely clear how the chemical and electronic input influence the cellular morphogenesis.

In *I've heard about …* Roche develops a mechanism to bypass the fixed and axiomatic apparatus/body divide. His habitat unfolds a concept of active citizen whose way of life is forever negotiable and emerges from the relationality forged with its neighbours rather than being externally managed. The political, or ethical, element of *I've heard about …* is recognized by Hélène Frichot who endorses this project as an example of a biodigital architectural practice that gets as close as possible to what she calls the *ethics of immanence* (discussed above).

> Roche […] is comfortable with discussing the ongoing influence of Deleuze, and even suggests we are all "children of Deleuze'. It is this practice that comes closest to operating across an ethical plan(e) of immanence, to borrow terminology from Deleuze and Guattari. This is especially evident through their close association of design practice with a life span, as well as their engagement in the malleability and hybridity of human subjectivity as it expresses itself in the design act (Frichot 2012, 35–6).

I agree that Roche's futuristic and provocative image of a self-constructed and self-sufficient, biodigital organism is unusual in its socio-political ambition at the time of its design and since. [243] Although his contribution to the articulation of alternative digital thinking is undeniable, his subjective position, as I showed above, is not sufficiently deterritorialized. What we are lacking is a new definition of the architect as a nonunitary subject.

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[243] A citizen 'welcome kit' includes an "*Agricultural kit*, m. (agriculture) -1. A set composed of living entities (animal and vegetable) that can be cultivated. Agricultural kits are meant to be used for food production (autarchy) and asepticizing the environment (light, atmosphere, pathology)" See Roche 2006, processes.

Part 2 – Transposition: from Scattered brains to digital artisan
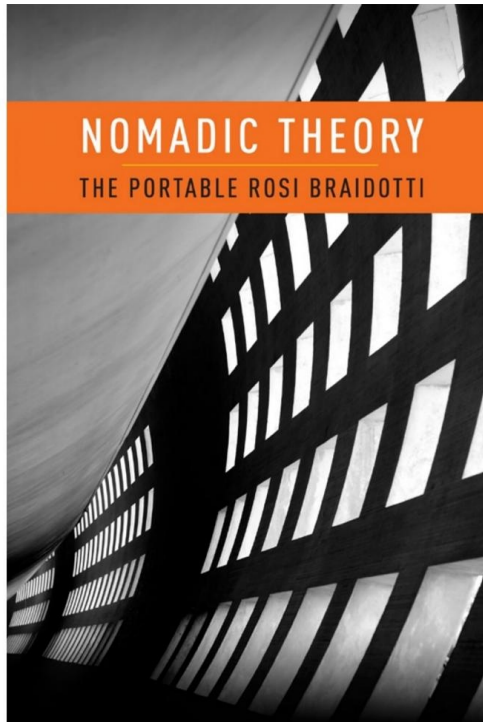
Nonunitary subjectivity

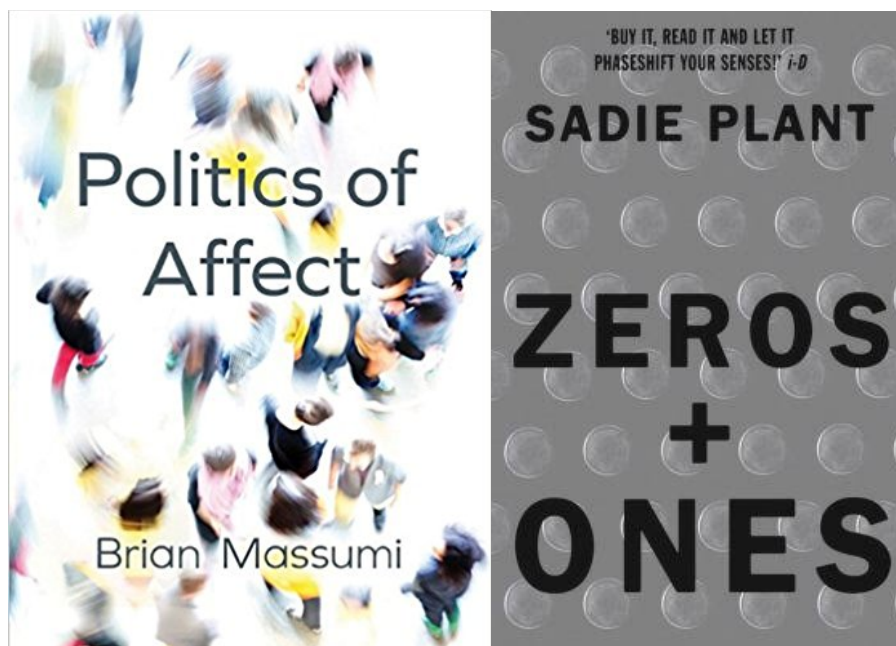**Figure 69: Rosi Braidotti, Nomadic Theory, the portable Rosi Braidotti, 2011, book cover image**

Figure 70 (left): Brain Massumi, Politics of Affect, 2015, book cover iamge
Figure 71 (right): Sadie Plant, Zeros + Ones, 1998, book cover image

One aspect shared by all critiques of digital discourse as captured above is a critique of compliance established towards non-liberalism by digital discourse, and a general lack of social/ ethical criteria. I turn to nomadic theory now for a reconceptualization of the process of critique itself entailed by nomadic thought as well as in order to bring to the fore creative nomadic alternatives suggested to overcome the ethical shortcoming of digital discourse. In this section I will refer to nomadic theory's reconceptualization of subjectivity along nonunitary lines, elaborating on its mechanism and process that set it apart from fixed subject position, as stemming from Braidotti's nomadic theory as well as developed by Deleuze. I show that Braidotti's *nonunitary* corresponds to two previously mentioned embodied aspects Deleuze engages with, the interchanging monad/ umwelt and the mechanism that enables Leibniz's differentiation within the monad – the embodied process allowing for the derivation of points of view/ perspective, which I already showed to be interchangeable with singularities.

In the previous chapter I showed how Deleuze moves to redefine these non-dualistic processes of non-human differentiations in nomadic terms; he does it with manifold/ multiplicity – a mathematical/topological redistribution of the differentiation process across an infinite field derived from Riemann and Poincaré's topological mathematical discoveries. I argued in cartography 2, part 1 that this redistribution, although dissolving the monad, nevertheless, still maintains the mechanism of differentiation by derivation. In Deleuze's work with Guattari – this correspondence takes up a different form, and in relation to a different humanist reduction – against neo Darwinian determinism.[244] As an alternative, Deleuze and Guattari place organisms as autopoietic systems.[245] In *A Thousand Plateaus* the focus shifts from the articulation of differentiation within a single organism towards ecology of singularities distribution as part of a machinic phylum. Such a shift, discussed in the previous cartography entails again two forces rendering one another possible, a flow of material (a machinic

[244] See cartography 2, part 1, where I show that the Leibnizian-topological one was taken up as a critique and creative alternative to the doxa, to the 'image of thought'.
[245] See cartography 2, part 2, where I refer to Keith Ansell-Pearson who shows that in Deleuze's own scholarship, the molecular or germinal is developed while drawing on Bergson's concepts of duration.

phylum) and assemblages (clusters of determination, which stratifies the flow). The shift to the nomadic that Deleuze and Guattari trace seems to be running counter to Braidotti's insistent on rearticulating the human. However, I show that despite Deleuze and Guattari's interest in the non-human, in the animal and the machinic, nevertheless they aim at rearticulating the human as post-human, amidst and encompassing molecular and germinal flow of materiality. At the end of this chapter I show that the subject is not neglected by Deleuze and Guattari but rather, it is articulated in these material flows, namely in the concept of the artisan. This is to say that Braidotti's nonunitary resonates with Deleuze, with or without Guattari's articulation of these forces, as a critique and at the same time, as an alternative of humanist fixed subjectivity.

What is the multiple, or to a greater degree, the machinic phylum if not an articulation of the flow of materiality that Braidotti relates her nonunitary subject to? (a subject position that replaces the humanist webs of identity, centred in relation to sex, race and earth.) Moreover, I show the nonunitary affectual perception capabilities and processes to be relying on Leibniz's derivation of *point of views*, reworked by Deleuze. It is important to note though that Braidotti draws on feminist discourse for her vocabulary, which changes the emphasis of Deleuze and Guattari's flows to incorporate a vital force that is life itself, or zoe:

> what 'returns' with the return of life as zoe and of 'real bodies' or neomaterialism, under the impact of advanced technologies, is not only the others of the classical subject of modernity, woman/native/nature. What returns now is the 'other' of the living body in its humanistic definition: the other face of bios, that is to say zoe, the generative vitality of the non-prehuman. Zoe stands for the mindless vitality of Life carrying on independently, regardless of rational control. This vital energy is the dubious privilege attributed to nonhumans and to all the 'others' of Man, whereas bios refers to the specific human capacity to construct a social nexus. That these two competing notions of 'life' coincide on the human body turns the issue of embodiment into a contested space and a political arena (Braidotti 2011, 99).

How does such a system work? How does a nonunitary subject relate to these ungoverned forces of life? How does such an understanding of nonunitary

subjectivity render the how and what of such an entity – that is, how does she relate and to what? What determines nonunitary subjectivity in the post-identitarian world Braidotti renders? Braidotti brings the answer back to the body, but a body wired differently than the humanist understanding of a body. Such a move entails redistribution of humanist stronghold concepts such as memory and time and their replacement with a reliance on perceptual mechanisms not within humanist register, such as affect. What binds us, claims Braidotti, as opposed to moral ideas, is an objection to the unitary conceptions of the subject which are 'indexed on phallogocentric, Eurocentric, and normative standardized views of what constitutes the humanist ideal of "Man."' These are replaced by –

> Unconscious memories as well as collective channels of neural and genetic information bind us more strongly than any moral imperative. They make our identities into collective, outward-bound, and retrospective entities – not at all the measures of all things, but more like a sediment accumulation of leftovers (ibid., 131).

Nonunitary memories

Braidotti further elaborates on these alternative bonds amidst a fixed subject perception, stressing the subversive role of such reconceptualisation, 'Memory as a molar tool is perceived as knowledge bank being guarded by the majority' tells us Braidotti, therefore, a counter method is a 'nonlinear philosophy of time as a zigzagging line' (ibid., 31). Nomadic subjectivity therefore entails undoing two of the most important human concepts, understood to be indexing the molar position– memory and time from the grip of humanity, undoing them from a master narrative and the dictation of chronos – the measured time. As an alternative, Braidotti stresses, 'Molecular, minoritarian, or nomadic memories are affirmative, destabilizing forces that propel subjects actively towards change (ibid., 32–3). These memories are in the realm of the virtual according to Deleuze, but that doesn't make them less "real." 'This type of remembering is not identity bound or ego indexed', 'it is linked to a radical process of deformalization or disidentification from dominant representational and even self-representational practices' (ibid., 33). Memories are nevertheless a

grounding element, always beginning from a place of pain and trauma; however, they should not stop there.

Instead of deference to the authority of the past, nomad thought proposes the 'fleeting copresence of multiple time zones, in a time continuum that activates and deterritorializes stable identities. It also offers a very dynamic vision of the time sequence of memory', 'The nomadic vision of the subject as a time continuum and a collective assemblage implies a double commitment, on the one hand, to processes of change and, on the other, to a strong ethics of ecosophical sense of community – of "our" being in *this* together' (ibid., 210).

> Remembering in the nomadic modes is the active reinvention of a self that is joyfully discontinuous, as opposed to being mournfully consistent, as programmed by phallogocentric culture. It destabilizes the sanctity of the past and the authority of experience. This is the tense of a virtual sense of potential. Memories need the imagination to empower the actualization of virtual possibilities in the subject (ibid., 229).

Braidotti stresses these creative alternatives 'not as an end in themselves but as steps in a process of recomposition of the coordinate of subjectivity' (ibid., 232). Memories power are in their collective character, and so their ability to connect subjectivity at the same time to a personal or to a collective memory as a mechanism of undoing a reliance on identity.

What is the mechanism of perception and how does it differ from the humanist reliance on cognition and vision? Although Braidotti touches upon the importance of affective relationality, this mechanism is nevertheless underdeveloped in her scholarship. I draw on Deleuze and Massumi for a discussion of how affect can render a nonunitary subjectivity.

Affects: articulating nonunitary singularities
The focus of this section is in framing affect in continuation with non-representational, non-dualist conceptualizations developed by Deleuze, and as an outstanding example of a Deleuzian concept that engages directly with subject location. As such, affect stands out as evolving a specific nomadic, embodied and molecular understanding of subjectivity that complements the predominantly ethologically focused *umwelt* and the generality of Guattari's ecological

expansion that traverses bodily boundaries and connects "in" and "out", as I developed in the previous chapter.

Referring directly to Deleuze's rereading of Spinoza affirms affect as a predominantly non-representational, non-dualist concept. 'By affect I understand affections of the body by which the body's power of acting is increased or diminished, aided or restrained'; 'An affect that is called a passion of the mind is a confused idea, by which the mind affirms of its body, or of some part of it, a greater or lesser force of existing than before (Deleuze 1988 [1970], 49). Deleuze develops this notion further:

> It is certain that the affect implies an image or idea, and follows from the latter to us from its cause. But it is not confined to the image or idea; it is of another nature, being purely transitive, and not indicative or representative, since it is experienced in a lived duration that involves the difference between two states. This is why Spinoza shows that the affect is not comparison of ideas, and thereby rejects any intellectualist interpretation, It is a process that involves transitions, passages that are experienced, duration through which we add to a greater or lesser perfection, and furthermore, these states, these affections, images or ideas are not separable from the duration that attaches them to the preceding state and make them tend towards the next state. These continual durations or variations of perfection are called 'affects,' or feelings (affectus) (Deleuze 1988 [1970], 50).[246]

Deleuze's treatment of affect changes its orientation through his encounter with Guattari. In *A Thousand Plateaus*, affect is specifically placed in opposition to psychoanalysis's construction of a fixed subject composed around deterministic and repetitive patterns claims Ansell-Pearson.[247] The non-representational element of the affect receives a non-determinate aspect and the emotional manifestation of affect, as that which can increase or decrease our capacity to be in the world, is muted. Another important element that is added to this deterritorialization of the subject in *A Thousand Plateaus* is a germinal, molecular modulation and a departure from humanist boundaries. Affect defines the

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[246] Deleuze, following of Spinoza assigns these feelings to affect: "An increased capacity of the body to act is, or 'the passage to a greater perfection' is called an affect, or feeling, of joy; the passage to a lesser perfection or the diminution of the power of acting is called sadness." Deleuze, *Spinoza: Practical Philosophy*, 50.

[247] See Keith Ansell Pearson, *Germinal Life,* 179–180.

relationality of materiality, human and non-human. The following definition adds the machinic to the conceptualization of affect:

> A body is not defined by the form that determines it nor as a determinate substance or subject nor by the organs it possesses or the function it fulfills. On the plane of consistency, *a body is defined only by a longitude and a latitude*: in other words the sum total of the material elements belonging to it under given relations of movement and rest, speed and slowness (longitude); the sum total of the intensive affects it is capable of at a given power or degree of potential (latitude). Nothing but affects and local movements, differential speeds. The credit goes to Spinoza for calling attention to these two dimensions of the Body, and for having defined the plane of Nature as pure longitude and latitude [...] (Deleuze and Guattari 2004 [1980], 287, original emphasis).

This definition allows Deleuze and Guattari to conceptualize 'a mode of individuation' that is different from a subject's conception (or any other essence for that matter) which they call 'haecceties in the sense that *they consist entirely of relations of movement and rest between molecules or particles, capacities to affect and be affected*' (ibid., 288, my emphasis).

However, the affectual relations as resulting in a point of view, which I elaborated on in cartography 2, part 1, are developed by Deleuze later in his independent writing as part of *The Fold.* Massumi, although drawing on *A Thousand Plateaus* in theorizing the political dimension of affect, draws on Leibniz through Deleuze for the articulation of the mechanism of derivation itself, though without openly adhering to this reference, as we see below. Drawing on the bare definition of affect as the 'ability to affect or to be affected', and on the way affect is developed in *A Thousand Plateaus,* Massumi in his book, *Politics of Affect* (2015),[248] emphasizes the political dimension of affect in its capacity to traverse subjects. Massumi highlights affect in its capacity to 'cut transversally across a persistent division, probably *the* most persistent division. Because the ability to affect and the ability to be affected are two facets of the same event', while the concept of affect ties these two together, as Massumi

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[248] I would like to comment on the structure of this publication – rather than the traditional essay format – this book is comprised of interviews between Massumi and various other scholars. This format, I believe is best suited for the launching of a discussion on the topic of affect as it leaves room for growth, change – relationality, an open-endedness, in an intensity that does not exist in a pre-written work.

further explains: 'One face is turned towards what you might be tempted to isolate as an object, the other towards what you might isolate as a subject [...] there is an affection, and it is happening in-betweenness' (Massumi 2015, 48).

We therefore depart from the realm of a unitary subject and into intersubjectivity, which is the definition of the political as well as an outcome of the process of differentiating. Moreover, Massumi developed the concept of what Braidotti separately refers to as nonunitary memory with affect. In the coming account, Massumi inadvertently confirms affect not only as enabling a nonunitary, nomadic bodily conception process, but also as relationality in the production of potentiality, yet, and very importantly, a situated one. It is a process of embodiment, or the bodily trace that is left by the affect understood as *memory* that I would like to turn to now.

Massumi points to a less cited aspect of the way Deleuze develops affect in his reworking of Spinoza, which is the way it marks a transition 'where the body passes from one state of capacitation to a diminished or augmented state of capacitation' (ibid.). The trace that is left in between these states (on condition that it is felt) constitutes a *memory*. Memories therefore are already affectual. This process Massumi describes as that which unfolds a bodily trace, a memory is the process of becoming singularity, which for Leibniz yielded a point of view, as I describe in cartography 2, part 1. Massumi does not, however, mention Leibniz or the differential calculus in this context, yet I show that the process he describes repeats it step by step. For example, two types of memory take part – registered and unregistered[249] – these, I argue, are interchangeable with the two types of consciousness that Leibniz suggests, *minute perception,* the unconsciousness and the *apperception*, which are the conscious perceptions. As I explain above, conscious perceptions are derived from minute perceptions, not composed of, but derived by a relation of differentiation that is the moment of singularity, the perspective, or a point of view. If, as I quoted in cartography 2, part 1, 'minute perceptions force open the door of my consciousness and invade me' which happens when my 'consciousness relaxes' (Deleuze, Vincennes Session, Leibniz Seminar 29 April 1980), then it is clear that we are now in the

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[249] See Massumi, *Politics of Affect*, 59.

realm of affective relations and, moreover, it is the bodily trace, that creates a point of view, or the moment of novelty. This helps Massumi to position memory in detachment from emotion;

> an emotion is a very partial expression of affect it only draws on limited selection of memories and only activates certain reflexes or tendencies, for example. No one emotional state can encompass all the depth and breadth of our experiencing [...] The same thing could be said for conscious thoughts. So when we feel a particular emotion or think a particular thought, where have all the other memories, habits, tendencies gone that might have come at the point? And where have the bodily capacities for affecting and being affected that they are inseparable from gone? There's no way they can all be actually expressed at any given point. But they are not totally absent either [...] They're still there, but virtually – in potential. Affect as a whole, is the virtual co-presence of potentials (Massumi 2015, 5).

This qualitative change is preceded by a 'shock', explains Massumi:

> For example a change in focus, or a rustle at the periphery of the vision that draws the gaze towards it. In every shift of attention, there is an interruption, a momentary cut in the mode of onward deployment of life. The cut can pass unnoticed, striking imperceptibly, with only its effects entering conscious awareness as they unroll [...] I'd go so far as to say that this onset of experience is by nature imperceptible (ibid., 53).

For that affectiveness to be registered, we need alternative methodological tools, and it is here that Massumi introduces *microconception*: which he relate to Deleuze and Guattari, explained as 'a perception of a qualitatively different kind. It's something that is felt without registering consciously [...] According to this notion of shock; there is always a commotion under way, a "something doing"' (ibid.). What Massumi refers to here as *Microperception* is a term developed by Deleuze without Guattari in *The Fold*.[250] It was translated *minute perception* by Charles J. Stivale who translated Deleuze's Leibniz lectures transcripts to English.[251] Massumi, however, does not relate this term in the context in which Deleuze uses – *microconception/ minute perceptions* being part of the Leibnizian process of derivation of a point of view. However, it is the discussion that follows

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[250] See Deleuze, *The Fold*, 98–102.

[251] See cartography 2, part 1, where I use this term as part of discussing Leibniz's process of derivation of a point of view.

that I find illuminating in the sense that Massumi argues for a way to become aware of the microperceptuality, and that this is part of the potential process. '[I]t's a way of acquiring new propensities, which if they become embedded in our everyday life are habits' (ibid., 64). This equates with Leibniz's differentiating between the unperceived, the mass, which in Massumi translates to the mundane, to that which escapes our differentiation processes because of its repetitiveness. This, claims Massumi, creates a paradox: if we can only be influenced by affect without accounting for the process but only realizing the outcome, how can we harness the power of affect into a creative process? For 'how can we master what forms us? And re-forms us at each instant, before we know it?' Massumi draws on Deleuze and Guattari to argue that '*nonconscious process is the birth of thought. It is the germinal thought, moved by the force of time to express power of existence in coming action*' (ibid., 66, my emphasis). It is the moment of having a perspective, of becoming.[252]

Therefore, Massumi's interpretation of the affective relates to a concept of hope, but distinguished from utopia in its aspirations in regards to duration, or time. In other words, hope is distinct from utopia on the grounds of the questions put forward that are always located in the present and not in an imaginary future, in the body.

> Capacitation of the body as it's gearing up for a passage towards a diminished or augmented state is completely bound up with the lived past of the body. That past includes what we think of as subjective elements such as habits, acquired skills, inclinations, desires, all of which come in patterns of repetition. This does not make the event any less rooted in the body. The past that the body carries forward in serial fashion includes levels we think of as physical and biological, such as genetic inheritance and phylogenies. *So there's a reactivation of the past in passage towards a changed future, cutting transversally across dimensions of time, between*

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[252] Contrary to Selbach and Loo in *Insects and other minute-perceptions in the Baroque house* who see in the humanization of the notion of *umwelt* a hindrance, I maintain that it is the case only if we keep to a human understanding of the human. However, if we move to nomadized subjectivity along nonunitary lines, as suggested by Braidotti, such humanizing acknowledges a non-human undercurrent already within the human. Such nonunitary, post-human articulations of subjectivity, I show, maintain a reliance on pre-human processes, minute perceptions that Selbach and Loo advocate. See cartography 2, part 2 for the framing discussion.

past and future, and between pasts of different orders. (ibid., 49, my emphasis).[253]

This relate to Braidotti's above-mentioned assertion on the transformative capacity of nomadic theory in general. Massumi captures the immanent aspect of affect without separating it from a singular embodiment. It is the idea that begins and ends with the body, but the beginning is always different from the end and what is in between can never be pre-known, (or in other words, differentiated). It is this relationality that I find valuable to my own work. Affect is an action, a transition.

> When I say that it all comes back to the body, I don't mean the body as a thing apart from the self or subject. I mean that the void *is* the region of in-mixing from which subjectivity emerges, it is the coming together of the world, for experience, in here-and-now prior to any possibility of assigning categories like subject or object. That affective region […] is not in-between in the intersubjective sense. And it is not intentional in the sense of already carrying a subject-object polarity. It's a brewing, the world stirring, what I call 'bare activity' (ibid., 52, original emphasis).

Here Massumi not only reaffirms the embodiment of the brain and the embraining of the body, as Braidotti puts it, but also discusses the mechanism by which such relationality takes place, by emphasizing the immanence of the process and the change or disregard of causality. None of the units pre-exist individuation; it is the relationality and the movement of information in both directions that create the individuation.

This dual act of anchoring affect as a mechanism articulating singularity, which is the emphasis both Deleuze and Massumi make, elaborates on the mechanism itself in relation to a subject by the merit of her having a body. The insistence on flows, on infinitesimal materiality traversing it, a material flow of memories, time fragments that are derived from this process according to one's affectual capacity, articulate the working of a nonunitary subjectivity, no longer bound to a monad. This is an important point to make, because it confirms Leibniz's

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[253] For Massumi this process defines the *event*, the continuation of the above quote reads: 'It's a coming event, through which such categories will return – and more. Their rearising, and what else comes with them, depends on the event. It's not the event that depends on their already being in place.' Massumi 2015, 52. In order to maintain consistency with my own conceptualization, I refer to the *event* as individuation.

differential mechanism as a mechanism of relationality and change that derived points of view/ perspectives/ singularities that differentiate monads in the Baroque world as a relevant mechanism to the derivation of singularities differentiating nomadic non-human subjectivities. That is to say that Leibniz's infinitesimal, although barred from producing difference in a mathematical context, as we saw in the last chapter, is transposed, inadvertently, to render a nonunitary, posthuman and nomadic mode of subjectivity.

Have we always been posthuman? How can the same mechanism render both the mono-input monad that expresses a selected world, and ours, the excessively wired and seemingly connected to all worlds? How relevant is this following assertion by Deleuze in *The Logic of Sense*?

> Leibniz then was right to say that the individual monad expresses a world according to the relation of other bodies with its own, as much as it expresses this relation according to the relation of the parts of its own body. An individual is therefore always in a world as a circle of convergence, and a world may be formed and thought only in the vicinity of the individuals which occupy or fill it (Deleuze 2015 (1969), 126–7).

It is the definition of 'vicinity' in this formula that has changed dramatically. The advances in information and biotechnology annul physical, visual, temporal (unitary) definitions of vicinity, they do not, however, change the fundamental reliance of relation of other bodies with our own on the relation of the parts of our own bodies even it does change our resolution of our parts and bodies. These bodies, nevertheless, are no longer bound by a definition of sex/ race/ specie; they are human/ non-human and our connections are made not only across sex and species but across temporalities. This is our own nomadic position, a position captured lucidly by Braidotti's articulation of a nonunitary subject:

> The intensive or nomadic subject is transgenerational and environmentally bound. As a living organism, it partakes of the shared time sequence of the genetic code, which makes it a collective entity that moves across species and beyond anthropocentrism. The human organism is an in-between that is plugged into and connected to a variety of possible sources, time lines, and forces (Braidotti 2011, 101).

The non-one is therefore a condition of being and at the same time confirmed and accelerated by information and biotechnology advances, before we move on to investigate how nonunitary is being accelerated by technological advances, I transpose this discussion to Ada Lovelace as a figure as well as figuration, an extraordinary example of a nonunitary reach across temporalities and which also highlight our relations to data.

Nomadic figuration: scattered brains

Figure 72: Portrait of Ada Lovelace, 1838, by A.E Chaton

The account to follow is not only an example of the validity of nonunitary subjectivity past and present; it also manifests the transversal power of *minor positions* (in this case, non-male) to transform *major discourse* as an example of the dynamic and affirmative role of transpositions.[254] Ada Lovelace, the mathematician and writer, a woman to whom is attributed the invention of the

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[254] In my account of Ada Lovelace I refer to Sadie Plant's 1997 book: *Zeros + Ones; Digital Women + The new Technoculture.*

first computer programme back in the mid-nineteenth century, was (also) diagnosed with hysteria:

> They said she was a nervous system apparently unable to settle down. She had what she described as a 'vast mass of useless & irritating *power of expression* which longs to have full scope in *active* manifestation such as neither the ordinary active pursuits or duties of life, nor the *literary* line of expression, give vent to' (Plant 1997, 31).[255]

Plant elaborates: 'she couldn't concentrate, flitting between obsessions, restless, searching' (ibid.). It is this physical 'condition' that Ada herself perceived as advantageous, precisely because the not linearity of her own processing system, the transversal connections, allowed her to perceive the imperceptible.

> I believe myself to possess almost singular combination of qualities exactly fitted to make me *pre-eminently* a discoverer of the *hidden realities* of nature,' wrote Ada, listing her 'immense reasoning faculties,' and the 'concentrative faculty' which allowed her to bring 'to bear on any one subject or idea, a vast apparatus from all sorts of apparently irrelevant and extraneous sources.' Because of 'some peculiarity in my nervous system,' [is this a hint about hysteria?] she had '*perception* of some things, which no one else has; or at least very few, if any. This faculty may be designated in me as a singular *tact*, or some might say *intuitive* perception of hidden things; that is of things hidden from eyes, ears & ordinary senses' (ibid., 176).[256]

Sadie Plant alludes to Ada's 'condition' as *scattered brains*,[257] but in the context of the nonunitary make-up of our 'central nervous system' which situates and transposes Victorian phallogocentric society's judgement call on female intellectual capacities, a 'condition' diagnosed by Freud as *hysteria*. The 'cure' for such a feminine 'condition' was to refrain from intellectually strenuous activity.[258] Although even Freud has mused on the potentiality of hysteria to operate as an alternative mode of being that is productive, as he is quoted by Plant: "in hysteria there is at the same time the possibility of another mode of 'production' … maintained in latency. Perhaps as a cultural reserve yet to come?"

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[255] Sadie Plant quotes from Dorothy Stein, *Ada, A Life and Legacy*, (Cambridge: MIT, 1985), 167.

[256] Sadie Plant quotes from Betty A. Toole, *Ada, The Enchantress of Numbers*, (California: Strawberry Press, 1992), 144.

[257] See Plant, 166.

[258] Ada was advised not to exert herself with math. See Plant, 32.

(ibid., 170).[259] It is the non-linear, rhizomatic thinking that Ada asserts to be her greatest intellectual asset: a scattered brain has enabled her to follow things *intuitively,* things *hidden from ordinary sense,* a condition turned capabilities.

But beyond Ada Lovelace as an example of an empirical *otherness* (not-one and non-human) mode of thought being subsumed by the state system, I also cite Ada as a relevant figuration because of her non-human, affective perceptual capabilities. However, after affirming these perceptual capabilities as evidently human, the *other* human, I will go on to call these traits nomadic rather than continuing to participate in the molar binaries.

Ada channelled these 'conditions' towards her mathematical work. 'Ada's method, as will appear, was to weave daydreams into seemingly authentic calculations' (ibid., 27).[260] Her 'condition' enabled her premature molecular resolution vision of the world, acknowledging the living materiality around her as neurological flows of information, in the same way that she saw beyond the materiality of Babbage's *Difference* and *Analytical Engines,*[261] beyond their immediate functional purpose and in the realm of seeing the world as data to be calculated, any materiality, which became her great ambition and her great vision which was so ahead of its time. As she wrote,

> A Newton for the Molecular Universe is a crying want; but the nature of the subject renders this desideratum of improbable fulfillment. Such a discovery (if possible at all), could only be made thro' very indirect methods; – & would demand a mind that should unite habits of matter of fact reasoning and observation, with the highest imagination, a union unlikely in itself (ibid., 256).

Today, we can identify her methodology to be vitalist, by means of following matter, crossdisciplinary, rhizomatically, affective. It is her disadvantageous social position (on account of gender), of being already and always *not-one*,

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[259] Sadie Plant quotes from Luce Irigaray, *This sex which is not one* (New York: Cornell University Press, 1992), 138.

[260] Sadie Plant quotes from Doris Langley Moore, *Ada, Countess of Lovelace*.

[261] The *Difference Engine*, an early calculating machine, verging on being the first computer designed and partially built during the 1820s and '30s. While still working on the Difference Engine, funded by the British government, Babbage shifted his attention and began working on his *Analytical Engine*, generally considered the first computer. Babbage worked on it until his death in 1871.

which enabled her to fully embody her non-harnessed, nonunitary porous position and to maximize her capacity to affect and be affected. Her work in this context is truly alien, which she fully acknowledged:

> When she reflected on her own footnotes,[262] she was 'thunderstruck' by the power of the writing. 'It is especially unlike a *woman's* style surely,' she wrote, 'but neither can I compare it with any man's exactly' (ibid., 256, original emphasis).
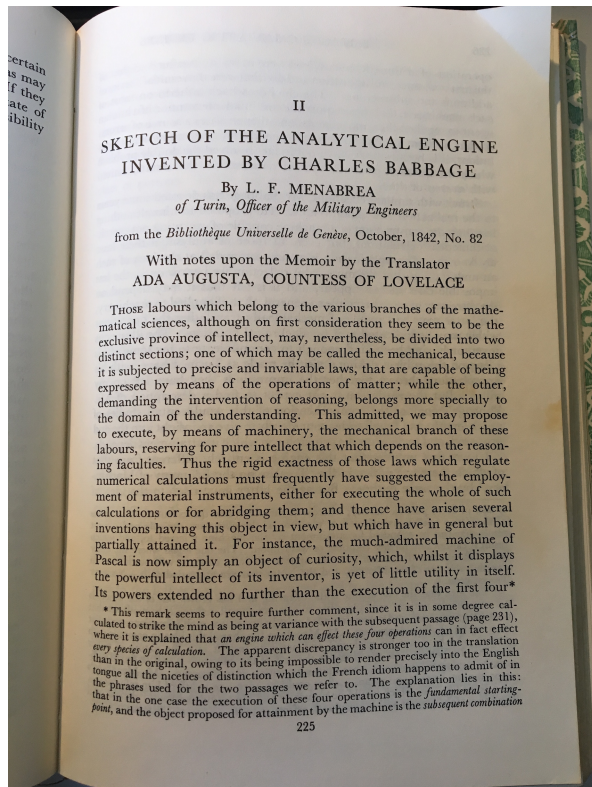

Figure 73: Sketch of the Analytical Engine Invented by Charles Babbage By Manabrea, translated by Ada Lovelace, taken from Charles Babbage and his Calculating Engines edited by Philip Morrison and Emily Morrison, Dover publications, 1961

In 1979 'Ada' became the official name of the American Department of Defence's computer programming language, in honour of her vision.

> If the supposed lack of such a central point was once to women's detriment, it is now for those who thought themselves so soulful who are having to adjust to a reality in which there is no soul, no spirit, no mind,

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[262] Ada Lovelace's extraordinary contribution to the development of computer logic in terms of developing the first computer language came at a footnote format as she translated an Italian engineer's (Menabrea) of Turin notes on Babbage's lecture from Italian. (*Sketches of the Analytical Engine Invented by Charles Babbage,* 1842) Ada translated his notes on the Analytical Engine, invented by Babbage (which she herself was involved in developing). Her footnotes to Menabrea's text exceeded the original text three times and are considered as remarkably ahead of its time mathematical and philosophical thinking.

> no central system of command in bodies and brains which are not, as a consequence, reduced to a soulless mechanistic device, but instead hum with complexities and speeds way beyond their comprehension. This is not a brain opposed to the body. This brain *is* body, extending even to the fingertips, through all the thinking, pulsing, fluctuating chemistries, and virtually interconnected with the matters of other bodies, cloths, keyboards, traffic flows, city streets, data streams. There is no immateriality (ibid., 166, original emphasis).

This is an example of movement in the opposite direction: from the majoritarian to the minoritarian, whereby all the pathologies of a pre-computerized world have become the conditions of post-humanist informational generation. It is not to say that there is a different appreciation of these qualities but rather the argument is far more subversive. It proves any pretense at unity or hierarchy, on either epistemological or ontological levels, to be insufficient.

> By the end of the twentieth century, only the most one tracked, fixated, single-minded individuals continued to think that focus and concentration worked […] High-resolution, high-definition minds are antenna to the parallel processors, intuitive programs, nonlinearities, interactivities, simulation systems, and virtualities of the late twentieth century. A strong sense of identity and direction gets one nowhere in cyberspace (ibid., 170).

However, as we saw throughout the thesis, this endorsement is epistemic only. How can it lead to an ontological shift, to real difference? How can we transpose Ada's story that spans two centuries confirming that binary cannot stand the flow of imperceptible, affectual flows. How can scattered braininess that underpins our technological world transpose to complex reality and, moreover, a realization of brain embodied?

Braidotti reminds us that this post-essentialist human condition has always been there, attributed to the empirical *other* of the molar condition and that current advances in information and biotechnology have made the shift visible as well as accelerating it in a way that it is now assumed by the molar position, but without creating a qualitative difference in the *other's* empirical conditions, positions and rights. At the same time, Braidotti claims, nomadic theory that relies on a radical non-essentialist approach does not aim at restoring equality between the *centre* and the *others*, but rather to account for the shift occurring in the other direction

– that of becoming, becoming woman/ minority/ non-human. 'In the process of recognizing, coding, and coping, they transcend their sheer animality, joining up with the human in the effort to express, inhabit, and protect their territory' (Braidotti 2011, 102).

The Digital Artisan: imagining digital subjectivity

I have argued throughout this thesis that digital architecture is in need of nomadic ontology to counter its post-humanist epistemologies in order to prevent it from falling back onto universal, deterministic and formal solutions, all of which are incapable to account for difference. Our neoliberal society is not short of physical diversity, but the obstacle to differentiation, as already argued by Braidotti, Massumi, Preciado and Clough, is that the production of visual difference does not translate to changed norms and is merely a late capitalist mechanism for profit and control, consuming subject architects and subject-users alike. Therefore the narrative of our society is a narrative of equality, diversity and difference, yet the margins remain unchanged. Reclaiming nomadic discourse from the grip of advanced capitalism entails tapping into its own system, the very system that subsumed nomadic thought, tapping into its molecular methodology that dissects our subjectivities to atomized fragments of data as a means of control. Grounding these flows of data is therefore a counter mechanism towards an ethical digital production; therefore, in this closing section of this thesis I show how a nonunitary digital architect's position can transpose digital architecture into the nomadic realm of difference production. I therefore suggest a new figuration, that of *the digital artisan* who follows imperceptible data for purposes of differentiating points of view, muted and marginalized.

Braidotti reminds us the importance of embodiment in our current biotechnological world as an ethical position.

> Being embodied in this high-tech ecological manner means being immersed in fields of constant flows and transformations […] The core of the matter is the relentless generative force of bios|zoe and the specific

> brand of transspecies egalitarianism they establish between human and nonhuman others (Braidotti 2011, 101).

I claimed earlier that I find Deleuze and Guattari instrumental to the development of nonunitary subjectivity as I draw on their non-human articulation of matter as vital, affective and embodied with Braidotti's anchoring of these flows in posthuman subjectivity. I showed specifically how affect, the engine of nonunitary subjectivity's relationality, relies not only on Deleuze's reading of Spinoza, but also on his reading of Leibniz, developed further through the ethological studies of Uexküll. While Spinoza articulates a general theory of affect, it is Leibniz who provides an intricate system of non-dualistic relationality founded on affectual derivations of point of view, differentiating individual monads. Uexküll, drawing on the animal world, connects affect to a biological ecosystem, later to be transposed by Deleuze and Guattari to encompass the non-organic – machinic and the molecular – to a multiplicity.

As I suggested above, Deleuze and Guattari render not only the machinic, or the flow, but contribute in terms of a specific figuration. That is to say that their emphasis on multiplicity is not without an articulation of subjectivity. It is here, in the closing section of this thesis that I draw on the correspondence between the machinic flow and Deleuze and Guattari's *artisan*, because I see this figuration in its capacity to transpose digital architecture to a nomadic realm.

> We always go back to this definition: the *machinic phylum* is materiality, natural or artificial, and both simultaneously; it is matter in movement, in flux, in variation, matter as a conveyor of singularities and traits of expression. This has obvious consequences: namely, this matter-flow can only be *followed*' (Deleuze and Guattari 2004 [1980], 451, original emphasis).

The *artisan* therefore is confirmed as 'one who is determined in such as a way as to follow a flow of matter […] it is intuition in action' (ibid., 452)*.* This definition is in direct opposition to that of the architect, because the architect, as we saw, operates the hylomorphic model. It is matter that conveys singularities not the

opposite, it is the differentiation that brings about points of view, therefore following the material brings it out to the limelight.[263], [264]

Deleuze and Guattari describe an affectual relationship between the artisan and his material in terms of the process, which begins with finding the 'right' material. I draw on this relationship because Deleuze and Guattari describe an embodied 'selection' process that is an affectual one, it implies a reliance of the artisan on his umwelt when following the flow of material. In our digital world, however, this separation between the artisan and the flows of material is impossible, since the digital material both encompasses the outside and is composed on the inside. As we saw above, when discussing affect, the emphasis is on the affective relationship that leads to the articulation of a point of view, which in turn material is being followed. Deleuze and Guattari compare the matter-follower relationship to music: in metallurgy, '[…] variability of matter tends to be replaced by the matter of a continuous variation. If metallurgy has an essential relation with music, it is by virtue of not only of the sounds of the forge but also of the tendency within both arts to bring into its own, beyond separate forms, a continuous development of form and beyond variable maters, a continuous variation of matter: a widened chromosomaticism sustains both music and metallurgy.

It is not a metaphor that I am interested in here, but rather the process of *following*, the process of following a material line that is guided by affectual relationality, which, as we saw, is a means of grounding, albeit nonunitarily. This process of grounding is not compartmentalized into humanist categories (sex/ race/ specie), but rather according to nonunitary affiliations and connections. It is the process of physically connecting to the underflows, the subsoil by intuitive and affective means.

> what metal and metallurgy bring to light is a life proper to matter, a vital state of matter as such, a material vitalism that doubtless exists

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[263] Deleuze and Guattari refer specifically to metal and to the metallurgist in their discussion of the machinic phylum.

[264] There is a difference between the artisan and the nomad, while the first occupy a smooth space, the latter is considered with matter-flow, see Deleuze and Guattari, *A Thousand Plateaus*, 452.

everywhere but is ordinarily hidden or covered, rendered
unrecognizable, disassociated by the hylomorphic model. Metallurgy is
the consciousness or thought of the matter-flow, and metal the correlate
of this consciousness (ibid., 454).

I said that it is the practices of following that I am interested in, following the
digital machinic phylum as it folds and unfolds from data. A digital artisan,
therefore, needs to divert methodologies already in place to follow other types of
data, covered, hidden, in the depth of the system, by enhancing the great
technological leap of techno-sciences and biosciences in the molecular, the zeros
and ones the converge all materiality. It is the imperceptible data, data that is not
registered by our human faculties, and that would only be perceived at an
affective level. Transposing data from its exploited advanced-capitalist place at
the hand of corporate, governments and agencies, which are interested in
quantitative difference, and into the realm of flows of data that capture not fixed
identities but fragments of collective memories, of stories, dreams, feelings. That
is tapping into the same resources that restrict us for reclaiming the nomadic as
a means of differentiating, to give to the suppressed ecologies of those muted a
voice in shaping a future to enhance their potential. This is a transposition.

How? By tuning into *microperceptions* either by surrendering to scattered-
mindedness or by using technologies that help us 'see' and 'feel' affects. This
methodology entails an embodied brain and an embraind body. These tools are
data detectors – either digital devices or bodily internalized residing within, in
the case of strong affective capacity. Each digital artisan's *umwelt* is unique and
so is the intensity with which he or she filters data, which differ according to a
point of view that is embodied and unique. Therefore, this process is truly
relational in-betweenness.

The barrier is not technological but ontological. It is therefore imperative that a
digital artisan ask the right questions when following his or hers scattered-
mindedness. In our current advanced-capitalist phase, all bodies are muted and
prevented from reaching their affectual capacity, but some are more muted than
others. A digital artisan is seen as scrap collector, a storyteller of bodies as data –
but not only the universal skeletal data, that furnished the tables and charts of

modernism: standard height, standard corridor width, standard bed-size, standard right to light, standard noise levels. The module, the linear positivist production line producing a standard good for standard needs, the type of data that manages our bodies according to a universal ideal, formal and functional. Why is architecture in a non-standard age still burdening itself with these measured, calculated, striated means of encasing bodies in efficient buildings when instead it can use the endless processing and collecting capacities to ask questions from a different order, a machinic order that in our differentiated age could make real differences to all of our lives, but especially to the lives of those who are voiceless and vulnerable, by following the data that affects them, to address their many layers of ecologies.

It is time to imagine how the capacity of relationality that is mathematically differential-based with the power of computation to process endless variations, coupled with fabrication techniques that realize the change from standard to non-standard, will be put to use in imagining new relationships between intersubjectivities. Roche and Lavaux have started an important process of addressing the social formations that our architectures allow for, and experimented with social formations with minimum disciplinary, regulatory external standards. *I've heard about …* is the beginning of a thinking process that addresses a similar question to the one this thesis hopes to answer, which is: how can we harness the majoritarian power to cultivate other ecologies? Roche and Lavaux were mainly interested in social ecology. I would like to expand on the in-betweenness that is formed amidst our emotional and physical ecologies; what questions do we need to ask and what apparatus do we need to mobilize for following this data? Roche and Lavaux's collection methodology aimed partially at data arriving from non-representational sources; as we saw, however, the sensors collecting the data arriving from chemical emissions in reaction to anxiety levels do not equate with affect relations and the subject perception implied in this project is a fixed, centred subject position.

It is Ada's scattered brains, the fleeting, shifting, flickering, passing, jumping and porous mode of being, that is not-one, which enabled her forward and alien thinking. A digital artisan needs to make the scattered brains his or her

methodology as well as ontology. This is especially potent against the background of the current political environment in Europe and across the Atlantic, which aims to pull us back to segregated fixed societies while taking advantage of nonunitary media outlets.

CONCLUSIONS

I began this thesis with the aim of uncovering concepts of novelty in digital architecture as a new field of architectural production, novelty, which its narratives positioned on the premise of a new post-humanist horizon. Intrigued by this proposition, I therefore embarked on an enquiry of how post-humanism changes architecture's practices, how it frames its 'novelty', and under what premise. And what are the implications of such novelty to our subject position – architects and users? As I showed at the beginning of this thesis (cartography 1), the answers to these questions were various and varied, and not only epistemically – on questions of how this endeavour may be approached and according to what techniques. The perceptions of novelty in digital discourse framing its first narratives, which I addressed in cartography 1, narrative 1, also differed ontologically – conflating stylistic definitions of novelty with a new paradigm. This conflation was particularly potent in the texts and projects of the first issue of *Folding in Architecture* and more so in the narrational gaps forming between the two prints, which span a decade.

To add to this state of incoherence, despite their epistemic and ontological differences, all these narratives shared one anchor point – Deleuze's *The Fold* – but how was it possible for these first narrators of digital novelty to define themselves as post-humanist and at the same time to adhere to a new style, a new form? This question was especially pertinent given that post-humanism in general and Deleuze's concepts in particular undo the human from representational methodologies (derived from styles) and call for an alternative relationality (which cannot be attained by adhering to visual standards). My first findings, therefore, revealed discursive gaps between these two bodies of work – digital architecture and post-humanist critical theory.

From the outset of this investigation, it was clear that digital architecture is in need of a clear set of definitions to account for the multiple positions, each with its respective vocabulary and terminology derived from fields as varied as the positions taken, to include critical theory, biology, mathematics and

computation, all nonetheless underpinned by a general shift in describing matter relations. That is to say, all these disciplines, in their own terminology and methods, described processes and systems that cannot be explained by central control, and parts of them relate according to forces which are unforeseeable and beyond human control; in short, this terminology was pointing towards a new paradigm, to a break from humanist discourse. How can these processes (differentiation/ generation/ emergence) equate with architectural insistence on formal attributes, such as folding?

I showed that, with the shift to digital platforms in architecture (at the end of the millennium), these tensions persist in the narratives of the *algorithm*. Not only were they not resolved, but rather they intensified. Unaware of this hybrid position, and with the introduction of specialized methodologies deriving from external disciplines, architects and historians, attracted by these new techniques, failed to account for the threads, the genealogies, that tie these new methodologies to humanist disciplines by which they believed themselves not to be bound. In cartography 2, I tied the links between the digital methodologies and their respective disciplinary ontologies, to uncover that the tension I describe above – between humanist ontologies and post-humanist methodologies – already resides within these external methodologies, which operate on the premise of axiomatic, rational, deterministic and universalist assumptions. All of these are residues of past practices, enabled by strong methodological links to humanist thinking. In mathematics, I frame these humanist tendencies as axiomatic and finite interpretations of the differential calculus (cartography 2, part 1). In biology, I frame these tendencies of the neo-Darwinist evolutionary processes as deterministic, disembodied, universalized approaches to evolution (cartography 2, part 2). These hybrid approaches to digital architecture practices that I have unravelled throughout the thesis hinder the production of novelty in the discourse, if by novelty we adhere to post-humanist concepts: this was my first conclusion.

Accounting for these gaps, for the convoluted and hybrid state of the discourse located across different disciplines, techniques, methodologies and histories, called for a dynamic methodology that not only accounts for the precise position

of each discipline, but also allows for new encounters to emerge: I found *nomadic methodology* to be the most suitable for addressing these numerous positions. *Cartography* proved a dynamic and precise approach, which enabled me to traverse these varied sites: differential mathematics, topology, evolutionary computation, with the first aim – of differentiating digital architecture's narratives of post-humanism from these humanist processes by carefully relocating, tracing back, the lost connections between the operating systems and their histories.

In this thesis, I have presented a critical account of these subsuming tendencies on the part of the discourse of digital architecture, subsuming nomadic philosophies and methodologies that underlie modes of thought which form the base of digital practices. Drawing on Deleuze and Braidotti, I have argued throughout the thesis that this convoluted state of the discourse is a socio-political location – that is to say, that these tangled discursive webs do not merely reflect a relational, connected reality but, rather, attest to our stage of advanced capitalism that has subsumed the nomadic operating system which allows such regimes (i.e. those of advanced capitalism) to mutate and differentiate constantly. This, however, does not create real difference, nor real diversity. Rather, it is difference as a means to maximize capital that is being differentiated. It is here that the apolitical stand taken by key figures in the parametric world, with the most vocal and recognized within it – Patrik Schumacher – triggers a backlash which questions the very premise of the discourse's operating system.

It is here that I locate the position of this thesis as unique, because it allowed me to depart from this humanist-dualist critique and to conceptualize alternative practices that are inseparable from the very act of cartography. By undoing the reliance of digital architectures on these humanist ties, I also retie digital discourse with alternative practices. That is to say that transposition is an act of derivation. This is seen as an act of resisting the mutations of advanced capitalism by means of reclaiming nomadic practices.

Throughout the thesis there is a simultaneous act of ravelling by unravelling, where the thread that is undone is then rewoven: unravelling the links that burden digital architecture with its modernist and postmodernist past, and with the humanist traditions that they entail epistemologically and ontologically – representational techniques and dualistic relationality – while at the same time my cartography also unravels alternative, hidden, nomadic traditions, both in architectural practice and in the mathematics and biologies that underlies it. These materialist and differentiated practices differ from the materialist and relational practice digital architecture adheres to – these forgotten nomadic sciences do not disconnect the material and relational from an *embodied* practice.

I have shown the importance of embodying a practice as an alternative to the disembodied new materiality of digital discourse – by reconnecting the mathematical digital discourse that operates differentiation to an interpretation of Leibniz's infinitesimal differential calculus as a mechanism for the derivation of a point of view, a process that does not operate upon a universal standard but that is embodied through microperceptions and the affects that they capture and emit that lead to the derivation of a point of view, a location. This location, we are reminded by Braidotti, is nonunitary and never fixed, or all-encompassing. Deleuze and Guattari conceptualize this aspect of the nonunitary in terms of the *germinal,* the *molecular*. I refer to their *machinic phylum* in cartography 2, part 2, as a means to counter the biodigital discourse on evolutionary processes that entail an enclosed organism as a means of reconnecting to flows, machinic flows. I have shown how we can differentiate from the machinic and still maintain our relations to it by means of an affectual, embodied awareness.

Reclaiming nomadic practice enabled me to make an act of resistance to the regimes of homogeneity that are masked by difference; it enabled me to create a figuration – *a nomadic artisan*, as the embodiment of a nonunitary digital location. Data is the digital artisan's materiality, and means of resistance, as he or she follows the data which is other than the rational, the skeletal, the universal data that relates us to one ecology while neglecting our other ecologies. Guattari relates us to two more, to a social and emotional ecology. I propose thinking of

data in relation to *umwelt,* which I refer to in my last cartography, that does not categorize, but internalizes the concept of ecology, traversing bodily boundaries. These affectual, imperceptible capabilities that connect us to these plethora of ecologies, to the flows are not new. As I argued through Leibniz, Uexküll and Ada Lovelace, they have always been part of the human, although demeaned, attached to the *Other,* the not-one, the not-human. Our current digital age merely exposes them as our human-nomadic condition and further enhances them. By realizing this dependence of the affectual, pre/post/ non-human on a body in relation to the machinic/ molecular/ germinal, the data flows, the digital artisan embodies these ecologies and reconnects to alterative bonds, to the collective — collective temporalities, collective memories, traversing and diverging the molar to better relate and empower the marginalized, those muted by neoliberal regimes, by means of enhancing their capacities. This is always a relational process that accounts and emerges from the unique location of each digital artisan.

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