# AN AGENTIC ACCOUNT OF DESIGN INTENTIONALITY IN COMPUTATIONAL ARCHITECTURE

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## ABSTRACT

### AN AGENTIC ACCOUNT OF DESIGN INTENTIONALITY IN COMPUTATIONAL ARCHITECTURE

Tüntaş, Duygu
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This thesis aims at understanding alterations in the conceptualization of design intentionality in relation to technological advances that bring new synthetic configurations to the world of design. The concept of intentionality used to be defined as central to human consciousness hence design intention regarded as exclusive to the human mind. The contemporary technological/ontological condition seems to displace this conceptualization of design intentionality sustained in conventional design processes, to think of design intentionality as embedded within computational agents through continuous feedbacks from designers, and reciprocally, designers' intentionality is altered and expanded as a reflection of the emergent outputs from the computational world. Computational processes and their objects of design exhibiting the 'emergent', 'unpredictable' qualities are then expected to become accessible to the human mind by the formation of nested processes of interchanges between designers and computational agents. This study introduces the concept of 'agency' which brings a critical approach to the anthropocentric view on design intentionality by shifting the focus from the human towards distributed models and hybrid constellations including both human and nonhuman for a reconceptualization of design intentionality and the possibilities for its augmentation. To acknowledge the changing roles of the human and the nonhuman in the design process, this thesis postulates an 'agentic' reading

towards intentionality. Such reading allows the concepts of design intentionality and emergence to be reconciled by a breakdown of the structures of intentionality into the notions of ‘design agency’ and ‘design action’ and dissolves the either-or-condition that appears to be a polarity between human-centered and techno-centered approaches.

**Keywords**: Intentionality, distributed agency, emergence, computational architecture

# ÖZ

## HESAPLAMALI MİMARLIKTA TASARIM YÖNELİMSELLİĞİNE ARACILIK KAVRAMI ÜZERİNDEN BİR BAKIŞ

Tüntaş, Duygu
Doktora, Mimarlık Bölümü
Tez Yöneticisi: Prof. Dr. Zeynep Mennan

Eylül 2018, 113 sayfa

Bu tez, tasarım dünyasına yeni sentetik düzenlemeler getiren teknolojik gelişmelerle birlikte tasarım yönelimselliğinin kavramsallaştırılmasındaki değişikliklerin anlaşılmasını amaçlamaktadır. Geleneksel tasarım süreçlerinde insan aklına özgü olarak tanımlanmış olan yönelimsellik ve tasarım yönelimi anlayışının çağdaş teknolojik/ontolojik durum içinde yeniden tanımlandığı gözlenmektedir. Hesaplamalı aracılarda gömülü olarak bulunan tasarım yönelimselliği, tasarımcıların sürekli geri bildirimleri yoluyla değiştirilirken, tasarımcıların yönelimselliği de hesaplamalı dünyanın çıktılarının bir yansıması olarak değiştirilmekte ve genişlemektedir. Bu durumda, hesaplamalı süreçler ve onların 'oluşumsal', 'beklenmedik' niteliklerini ortaya koyan tasarım nesnelerinin, tasarımcılar ve hesaplamalı aracılar arasında gerçekleşen iç içe geçmiş değiş-tokuş süreçlerinin biçimlenmesi ile birlikte insan aklı için erişilebilir olmaları beklenmektedir. Böylesi bir insan-ötesi durum, 'aracılık' kavramını öne sürer. Aracılık kavramı, odağı insandan insan olmayana yayan dağıtık modeller ve melez kümelenmeler öne sürerek tasarım yönelimselliğine dair yaygın insan-merkezci görüşe eleştirel bir yaklaşım getirmekte, böylelikle tasarım yönelimselliğinin yeniden kavramsallaştırılmasını ve onun artırımının olasılıklarını ortaya koymaktadır. Tez, tasarım sürecinde insan ve insan olmayan aracıların değişen rollerini tartışmak amacı ile yönelimselliğe ilişkin 'aracılık' kavramı üzerinden bir

okuma önerir. Bu tür bir okuma insan-merkezli ve teknoloji-merkezli yaklaşımların arasındaki iki kutupluluk durumunu çözer.

**Anahtar kelimeler**: Yönelimsellik, dağılımlı aracılık, oluşum, hesaplamalı mimarlık

To Mehmet İlker Karaman and his dreams

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# CHAPTER 1

# INTRODUCTION

The present thesis aims to provide a conceptual framework to conceptualize design intentionality in computational architecture. The study assumes a correlation between design intentionality and design tools, one which is altered by the advancements in technology and extending capacities of intellectual tools, as well as, the changing tendencies and assumptions among designers regarding the articulation of architectural intent. Attempting to understand how the designer's intellectual landscape is shaped in its modes and reasonings by the technologies that provide new intellectual tools necessitates an examination and assessment of the concept of intentionality in relation to technological advances that bring new synthetic configurations to the world of design.[1]

Departing from a phenomenological account, the research focuses on the human-technology intersection and aims to understand how technological tools affect design intentionality and correspondingly how designers inscribe their design intent. This study claims that the difficult task resides in the issue of intelligibility concerning the interaction among human and nonhuman actors through perpetual feedbacks that define the roles and distributes areas of responsibility. In order to better understand and assess this specific interaction, the thesis delivers an agentic approach in

[1] The present project began in 2012 in response to rather immature versions of these considerations on the designer's role and authoring of computational design process. Prof. Dr. Zeynep Mennan's studio 'CoDeReL' (Arch 585) that I attended in Spring 2014 at METU, Architecture can be claimed to be one of the breaking points that establishes my position in this search, which later enhanced when I participated 'Encoded Matter' in Spring 2016, course given by Ezio Blasetti at Columbia GSAPP.

conceptualizing design intentionality in which human and nonhuman agencies can coexist and take part in design actions.

The introduction of the generative and emergent properties of algorithms in the design process requires an inclusive account of intentionality so that intentionality can be distributed not only among human agencies but also nonhuman agencies that possess different degrees and intensities of intentionality, whose sources of logic and organization originate from natural phenomena, therefore creating an ambiguity along the natural-artificial divide. Such a conception of intentionality decenters the human from the ontological center of design intentionality and blurs existing borders by offering hybrid constellations, the hybridity of which is sustained within the design process through correlative learning and distributed intentionality.

### 1.1. Context and problematic of the study

In the 1990s, a rupture in the history of architecture and design, later named as *the Digital Turn in Architecture*[2], has occurred by the introduction of digital tools in research and practice, which has been received with great excitement and euphoria immediately forming a strong tendency –even a subculture– among designers and design researchers.[3] The exploration of the generative potentials and emergent capacities of complex systems lead to privileging these new tools. The ability to compute massive data within the emergent and self-organizational capacity of new processes has created a specific interest in the field of architecture with the idea that,

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[2] The editor of the book, Mario Carpo, covers the two decades of digital design with in architecture, See: *The Digital Turn in Architecture: 1992-2012*. John Wiley and Sons, 2013.

[3] The establishment of multiple design research groups include but are not limited to the Emergent Design Group at the School of Architecture & Planning, MIT; Emergence + Design Group led by Michael Hensel, Achim Menges and Michael Weinstock in Architectural Association; Institute for Computational Design and Research, especially ICD/ITKE Research Pavilions led by Achim Menges and Jan Knippers at University of Stuttgard.

through the properties of complex systems, design can become an autonomous process that can order, self-organize and even, adapt itself. With such capacities of spontaneous self-organisation, these processes end up producing behavior that are "not at all random," even though the system is fed with "completely random initial conditions."[4]

The origins of this tendency can be traced back to the experimental studies of the architect Frei Otto[5] in the mid 20th century, who considers design as "problem solving" with "an intuitive understanding of the physical properties of structure," and denies artistic motivation to avoid "burdening a project from the outset with preconceived ideas."[6] This shift that has been called as one from 'form making' to 'form finding' informs the problematic of this thesis which is located at the very interface of design and technology, extended by the mutual promotion and sustenance of computational research based on the superiority and operational efficiency of computational tools in the management of complexity.[7]

In such a discursive field, the consideration of intentionality naturally dissolves and becomes an object of disinterest with the "triumph of the far from equilibrium paradigm," as Manuel De Landa asserts.[8] A strong remark on the disposal of intentionality is later followed and heartened by Mario Carpo's announcement on the

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[4] Stephen Wolfram. *A New Kind of Science.* Canada: Wolfram Media, Inc. 2002: 223.

[5] Frei Otto founded *Entwicklungsstatte fur den Leichtbau* (Development Center for Lightweight Construction) in Berlin in 1957. Between the years 1955 and 1972, he produced shell, tensile, pneumatic and space frame structures, mostly in the form of suspended roofs and tents, also including silos and water towers. Ludwig Glaeser. *The Work of Frei Otto*. NY: The Museum of Modern Art, 1972.

[6] Ibid. 9.

[7] Zeynep Mennan. "Mind the Gap: Reconciling Formalism and Intuitionism in Computational Design Research," *Footprint 15: Dynamics of Data-Driven Design*. Delft Architecture, Autumn 2014: 33.

[8] Manuel De Landa. "Matter Matters," Column in *Domus Magazine*. (Issues 884 to 897, Domus). 2005.

"dissolution of architectural authorship"[9] a fellow concept to that of design intentionality believed to be firmly grounded in the human subject. Following the 'first digital turn' in architecture, in order to demarcate the nature of the current paradigm, Carpo proposes *The Second Digital Turn: Design beyond Intelligence*, a statement that is grounded on the increase in data-compression technologies and the idea of Big Data.[10] According to Carpo, the increase of speed and capacity in electronic computing has led to quantitative advancements, representing not a breakthrough but a threshold, in the unimaginable posthuman complexity of "the new science of search" having as its outcome the new paradigm of "computational form-searching".[11]

### 1.2. Contribution of the thesis

The major contribution of this study is to reinstate a discussion on design intentionality that has been absent in the conventional discourse of architecture because of a strong presupposition of its unquestioned grounding in the human subject, and which is only becoming visible in its recent problematization in the posthuman context of computational architecture. The conventional notion of intentionality in architecture expresses a cognizance of a purposeful, predeterminate, planned and conscious act, therefore grounds itself in human consciousness. This consideration of intentionality as implicit and ubiquitous in the design act has remained unquestioned, reminding of Imre Lakatos's definition of a *hard core* surrounded by *a protective belt*, protecting the grounding concepts of a discipline from refutation until a paradigm shift occurs.[12]

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[9] Mario Carpo. *The Alphabet and the Algorithm*. MIT Press, 2011.

[10] Mario Carpo. *The Second Digital Turn: Design Beyond Intelligence*. Cambridge MA: MIT Press, 2017.

[11] Ibid. 47-48.

[12] Imre Lacatos. *The Methodology of Scientific Research Programmes* (*Philosophical Papers*: Vol.1), J. Worrall and G. Currie (eds.), Cambridge: Cambridge University Press, 1978.

When the new toolsets that the computational paradigm entails are introduced into architectural design, a new tendency occurs towards exploring the emergent properties and generative capacities of these tools, while at the same time delegating some of the design responsibility to them. This interest has been sustained by the great expansion in the possibility space of design towards an unknown and unpredictable world in architecture which the emergent properties of these tools facilitate. As a consequence, a concern for design intentionality has been suppressed and delayed for a couple of decades starting from the 1990s.

After more than two decades of exploration and expertise in these tools, the euphoria can be said to have dissolved, leaving its place to a remarkable condition in which we can no longer locate the subject of design, but rather need to find ways to hybridize the potentials of both human and nonhuman modalities. Such effort necessitates an exploration and reconceptualization of design intentionality in order to restate and reconcile the subjective and intuitive faculties with the emergent processes of computational tools by displacing the anthropocentric account of design intentionality sustained in conventional design processes. Considering design intentionality as embedded within computational agents through continuous feedbacks from designers, and reciprocally, designers' intentionality as altered and expanded as a reflection of the emergent outputs from the computational world, this recently forming discourse on design intentionality in computational architecture does not need to gravitate towards a stubborn opposition[13] where design intentionality is either centered in top-

[13] In *the Architecture of Good Intentions: Towards a Possible Retrospect*, Colin Rowe argues that, the reason for such oppositions is their residual adherence to an epistemology which was initiated and sustained by the Modernist architectural culture that associates subjectivity with the notions of irrationality and indeterminacy. In the establishment of the Modern project, certain approaches in architectural design are condemned as being unintelligible, and speculative, -such as the creativity in the subjective modes of operations. According to Rowe, such doctrine that condemns subjective creativity -in favor of functionality and typicality, in order to approach to 'objectivity'- is also followed by influential figures in architecture, Walter Gropius and Mies van der Rohe, who defined the dominant tendency in architecture and long restricted the repertoire of formal resources. See: Colin Rowe. "Epistemology," *The Architecture of Good Intentions: Towards a Possible Retrospect.* London: Academy Editions, 1994: 14-29. The simplicity of visual vocabulary sustained by this

down behavior of human-designers through a consciousness that only they can possess, together with its related notions and reasonings such as subjectivity, intuition, artistic expression; or is artificially constituted by the bottom-up generative properties of computational tools and associative technologies, namely, emergence, evolution and self-organization.

### 1.3. Methodological approach

A conceptual exploration of the terms intentionality and emergence is necessary in order to address such a reconciliation of the so-called epistemological oppositions of what these two terms connotate, such as; determinate-indeterminate, predictable-unpredictable, control-freedom etc. Therefore, the theoretical groundwork of this thesis has developed by bringing together two sets of conceptual frameworks and their vocabularies: (1) intentionality and (2) emergence. Studying the inner mechanisms of these concepts, the study will expand on intentionality –a concept which occupies the very core of designers' relation to their work– and the notion of emergence –a concept that has entered the world of design as an exploratory and generative device to inquire into the uncertainties and indeterminacies of computation.

Intentionality is conceptualized as an interface between the human and the nonhuman whose negotiation is conveyed in the trajectory of design through human and nonhuman agencies and their actions. Therefore, this thesis distances itself from the anthropocentric view of intentionality towards a non-anthropocentric account that

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doctrine that promotes "low information content" led to a success in spreading these standardized, typical and easy-to-replicate forms/structures. Considering Le Corbusier's Dom-ino House (1937) as a formal infrastructure of Modern architecture, Zeynep Mennan relates its success in invading the architectural culture of 20th century to its memetic advantages and adaptive power. In: Zeynep Mennan. "Questioning Graphic Rationality in Architecture: Experimentations on the Visual and the Non-Visual," Unpublished paper presented in *Architectural Education Forum 3: Global Architectural Education Area*, İstanbul, 2006. Mennan states that such preference of twentieth century for simplicity has been reversed with the complexity paradigm in which computational research is situated and "in possession of advanced and improved tools and methodologies that remedy such deficiencies, yet at the same time increase the complexity of design problems." In: Mennan. "Mind the Gap", 33.

appreciates both the human and the nonhuman by observing the echoes of their specific nature on design intentionality. To acknowledge the changing roles of the human and the nonhuman in the design process, this thesis postulates an 'agentic' reading towards intentionality. Such reading allows the concepts of design intentionality and emergence to be reconciled by a breakdown of the structures of intentionality into the notions of 'design agency' and 'design action' and dissolves the either-or-condition that appears to be a polarity between human-centered and techno-centered views.

In this respect, the study exercises a hermeneutical framework which provides a deeper examination of the complexity of the design process and the multiplicity of actors involved, through a holistic understanding of the human-technology relationship that decenters the long-established role of the human designer in emerging (human/nonhuman) hybrid constellations. In the background, the study announces a delay/dissolution of the epistemological oppositions or concepts conventionally regarded as antithetical, such as; human-nonhuman, subjective-objective, predictable-unpredictable by acknowledging the intricate formation of design actions and interlocking of agencies in computational design processes. Such remuneration of the contribution of the nonhuman and a possible intentionality distributed among human and nonhuman agents run parallel to the main discussion throughout the text.

Another important layer in the problematization of this study is the human-nonhuman divide in the anticipation on the future of design and corresponding distribution of the roles of human and nonhuman counterparts. On this exact divide, according to Mario Carpo, "the emergence of some inchoate form of artificial intelligence in technology" is the result of "the ongoing postindustrial separation of the minds of the thinkers from the tools of computation," quite similar to the Industrial Revolution that separates "the hands of the makers from the tools of production." [14]

[14] Carpo. *The Second Digital Turn*, 81.

Instead of a human-centered or techno-centered conception, this study anticipates a distributed conceptualization of design intentionality by reserving the human with the indispensable interpretive role and by appreciating the contributions of the computational tools as the support of innovation and novelty in design.

Considering the effects of the increased capacity of machine computation onto the designer's intellectual landscape, this thesis claims that the resonation of this intellectual development in the field of architectural design research occurs especially with the stimulation of the emergent properties of computational tools. The conventional account of a design trajectory between its 'problem space' and its 'possibility space' is altered with the change in the nature of design tools and expanded with the introduction of emergent properties of computational methods into the field of architecture and design. The semantic discrepancy and even antagonism between the concepts of intentionality and emergence, and a possibility of a reconciliation among these two through a hermeneutical approach create an epistemological excitement and generate a point of departure for this study. Furthermore, the implication of the emergent qualities of computational tools in the design process refreshes design thinking by subverting the conventional determinacy associated with the concept of (human) intentionality into the indeterminate and unpredictable nature of these intellectual tools.

As mentioned earlier, this study incorporates a hermeneutical framework that enables a possible reconciliation of the concepts of intentionality and emergence at the very interface of human-technology. Within this framework, the relationship between design thinking and design tools is established through a circular correlative process, which is sustained with the high-level of organizational potentiality of computational tools and enabled by the interpretive capacity of designers. The framework that questions the human-technology relationship at a deeper level is elucidated with

reference to the theory of 'material hermeneutics' developed by Bruno Bachimont as a criticism of formalism in artificial intelligence.[15]

Bachimont develops a theory of the support, examining the relation between intellectual tasks and material supports, to problematize the general and philosophical account of hermeneutics that aims to establish meaning by considering it independently of its material support.[16] He therefore proposes a theory of the support, according to which "all knowledge proceeds from a material inscription of which it is the interpretation."[17]

A hermeneutical approach towards a conceptualization of intentionality in computational architecture provides an alternative to the discrepancies that the concepts of intentionality and emergence are claimed to possess, such as human-nonhuman, determinate-indeterminate, subject-object etc. by promoting a circular correlative process among the concepts and actors involved in design process. The circle mentioned here refers to the hermeneutical circle conceptualized by Martin Heidegger[18] and later formalized by Hans-Georg Gadamer[19] in the field of phenomenology, which places the circularity of interpretation at the core of

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[15] Bruno Bachimont. *Herméneutique matérielle et Artéfacture : Des machines qui pensent aux machines qui donnent à penser; Critique du formalisme en intelligence artificielle*. PhD thesis in epistemology. Paris, École Polytechnique, 1996, cited in: Zeynep Mennan. "Mind the Gap", 34.

[16] Bruno Bachimont. "Formal Signs and Numerical Computation: Between Intuitionism and Formalism. Critique of Computational Reason." In H. Schramm, L. Schwart e & J. Lazardzig Eds., Theatrum Scientiarum: Instruments in Art and Science, on the Architectonics of Cultural Boundaries in the 17th Century, 2008: 366.

[17] Bachimont cited in: Mennan. "Mind the Gap", 34.

[18] Considered as one of the most significant texts in the contemporary continental philosophy Martin Heidegger's *Being and Time* (1927/1962) provides an account of the nature of understanding.

[19] Hans-Georg Gadamer. *Philosophical Hermeneutics.* Trans. David E. Linge. Berkeley: University of California Press, 1976.

understanding by considering the part-whole relations.[20] In *Being and Time*, Heidegger explains the notion:

> The "circle" in understanding belongs to the structure of meaning, and the latter phenomenon rooted in the existential constitution of Dasein—that is, in the understanding which interprets. An entity for which, as Being-in-the-world, its Being is itself an issue, has, ontologically, a circular structure. [21]

Jeff Malpas notes that the inclusive and applicable nature of hermeneutical circle "allows to enter into the dialogue with the matter at issue."[22] This means that "whenever we understand, we are involved in a dialogue that encompasses both our own self-understanding and our understanding of the matter at issue," and in this "dialogue of understanding our prejudices come to the fore, both in as much as they play a crucial role in opening up what is to be understood, and in as much as they themselves become evident in that process."[23]

Considering the dialogical and interpretive account of hermeneutics in general and 'material hermeneutics' in specific, this thesis focuses on the human-technology relationship, understanding the computational design process as a correlative learning process that decentered the long-established dominant position of the designer as the sole author by incorporating the emergent properties of computational tools into the world of design. Such a shift necessitates a reconsideration of the roles of the human

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[20] Jeff Malpas. "Hans-Georg Gadamer", *The Stanford Encyclopedia of Philosophy* (Winter 2016 Edition), Edward N. Zalta (ed.), Accessed in 2018/07/05 from https://plato.stanford.edu/archives/win2016/entries/gadamer/

[21] Martin Heidegger. *Being and Time*, John Macquarrie and Edward Robinson (transl.). New York: Harper & Row. 1927/1962:195. Quoted in: Chrysostomos Mantzavinos. "What Kind of Problem is the Hermeneutic Circle?," in: *Philosophy of the Social Sciences*. *Philosophical Theory and Scientific Practice*, Mantzavinos C. (ed.), Cambridge University Press, 2009: 302.

[22] Malpas. "Hans-Georg Gadamer".

[23] Ibid.

and the nonhuman and a reconceptualization of intentionality in the field of architecture and design computation.

### 1.4. Structure of the thesis

As a way of organizing what is a rather an intricate set of issues, the thesis first proposes a hermeneutical relationship between the designer's intentional content, modes and reasonings which are altered by the ingression of computational tools and emergent content. Such hermeneutical model necessitates using two sets of conceptual frameworks and their vocabulary with reference to the proposed relationship between the concepts of *intentionality* and *emergence* which are established through a hermeneutical relationship between designers' intentional content and the emergent content provided by the computational design tools. Studying the inner mechanisms of these concepts, the study will first expand on the term intentionality –a concept which occupies the very core of designers' relation to their work– and secondly, the notion of emergence –a concept that has entered the world of design as an exploratory and generative tool for approaching the uncertainties and indeterminacies of computation.

In order to postulate a more comprehensive account of intentionality, Chapter 2 expands on the hermeneutical relationship between intentionality and emergence with reference to Bruno Bachimont's theory of 'material hermeneutics', and then, the philosophical context and definition of intentionality is provided. For an attempt to find a contemporary definition of intentionality in the context of computational design, the use of the concepts of 'agency' and 'action' is proposed so as to reveal agentic capacities of the nonhuman by referring to the Deleuzian concepts of 'expressive agency' and 'assemblage', and Jane Bennett's concept of 'thing-power'. Overall, the chapter provides a specific vocabulary and visualization for a conceptualization of intentionality.

In chapter 3, the study identifies the notion of emergence as a facilitator to reinvent design thought. Therefore, focusing on the emergent properties and generative capacities of computational design tools which are conceptualized as "intellectual tools" that help production of new and novel ways of design thought, this chapter is devoted to exploring the gap created in-between the world of design and the world of computation that expects to be filled with developments in technology. In order to correspond to the question of design intentionality in computational architecture, it discusses the concept of emergence and the emergent properties that computational tools brought together, through which design action is extended and the possibility space is exponentially enlarged. This expansion in the emergent content also extends and redefines designers' intentional content through a continuous feedback mechanism where the design process is considered as an assemblage of bodies in which the fitting together is performed by design actions and component parts, which are human and nonhuman design agencies that all create an extended possibility space by the active participation of emergent properties of algorithms and codes.

Chapter 4 will instantiate and concentrate on the rare examples and specific approaches that reveals some inner workings of the so-called black box of intentionality and the intricate relationship between human and nonhuman agencies. Positing a criticism to the explanatory use of computational tools in architecture and design, the chapter will focus on the tendencies that are manifested with innovation at the interface of design and technology in computational design by recognizing the contributions of algorithmic agencies and reclaiming the subjective and intuitive design faculties.

# CHAPTER 2

## INTENTIONAL CONTENT: AN AGENTIC ACCOUNT OF INTENTIONALITY

The claim, generalized by now, that designers' intellectual landscape has been radically altered with the advancements in design tools -specifically with the introduction of an increased capacity of machine computation and practice with the emergent properties of these tools provided by the computational paradigm- seems incomplete without a reconceptualization of intentionality in the sphere of recent architectural design research that goes parallel to these developments and that opens a new historicity rejecting the dominance of human intentionality by problematizing the already established relations and connotations echoing around the concept of intentionality, such as predictability, consciousness, rationality, control, determinism, etc. To acknowledge alterations in the conceptualization of design intentionality in relation to technological advances that bring new synthetic configurations to the world of design, this chapter aims to provide for a discussion of the fundamental concepts around intentionality in the philosophical, anthropological and technological spheres, in order to reflect them onto the field of architecture and design.

This study proposes a relationship between the concepts of *intentionality* and *emergence* which is enabled by the interpretive capacity of designers and sustained with the high-level organizational capability of computational tools. A hermeneutical framework between designers' intentional content and the emergent content provided by the computational design tools is anticipated to establish such correlation.

This study identifies the emergent properties of computational tools as a facilitator to reinvent design thought, as a concept that has entered the world of design as part of an exploratory and generative approach for dealing with the uncertainties and

indeterminacies of computation. The concept of emergence will be discussed in detail in Chapter 3.

### 2.1. Hermeneutical relationship between intentionality and emergence

On the human-technology interface, a hermeneutical process that examines the relationship between design tasks and design tools can be clarified with reference to the theory of 'material hermeneutics' developed by the French epistemologist Bruno Bachimont.[24] Bachimont's epistemological discussion claims that "technology is the condition for the elaboration of knowledge," since the technological tools mediate the constitution of new knowledge and concepts through the structuring that they convey into "the time and space of our experience."[25] He further indicates that the change in our modes of thinking and externalization of thought is entailed with the change in the material instruments and intellectual tools.[26] Translating Bachimont's account into the realm of architecture and design computation, it can be understood that any alteration in design tools, which bring about a new structuring into the world of design, will have effects on the modes of design thinking and design action, eventually informing and redefining designers' intentionality.

21st century's upsurge in technology has profoundly increased the capacity of information processing in order to respond to the complexity of design issues, but

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[24] As a criticism of formalism in artificial intelligence Bachimont develops a theory of the support that explores the relation between intellectual tasks and material supports. Bruno Bachimont. *Herméneutique matérielle et Artéfacture : Des machines qui pensent aux machines qui donnent à penser; Critique du formalisme en intelligence artificielle*. PhD thesis in epistemology. Paris, École Polytechnique, 1996, cited in: Mennan. "Mind the Gap", 34.

[25] Bachimont. "Formal Signs and Numerical Computation", 371.

[26] Ibid. 366.

according to Bachimont, the real significance of computational tools lies in creating a breakthrough in the history of tools with their inventive power in thought processes.[27]

Conceived as an intellectual act, for Bachimont, the act of writing builds "on the execution of an intention," works as a technique enabling the intellect to create "new synthetic configurations" in which the "constitution of new concepts" becomes possible.[28] As he expresses:

> By instrumentalizing our experience by means of repeatable methods and tools that extend our action, technology transforms our relation to the world, and leads us to think it differently, to the extent that we do not only think differently a world that stays the same, but that we constitute new worlds, with large or small ruptures between.[29]

When transferring what has been just observed in relation to writing into the field of design, it can be stated that conceptually, design action is similar to the act of writing, yet, it differs from writing in the capacity of its constituting agents and intellectual tools, i.e. the "material instruments and supports,"[30] for the exercise of thought. In design process, we will observe a larger body of human and nonhuman assembly whose trajectory can be traced by detecting the design agents and actions. Some of the phases or actions in such processes can be named as conceptualization, speculation, trial and error, branching, deviation or make a detour, evaluation etc. (Figure 1) However, with the alterations in design support, i.e. intellectual tools and their corresponding modes of thought, the operations change their nature.[31] By means of the introduction of computational design tools in the design medium, such changes in the nature of the design support make information processing easier yet the assessment of

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[27] Ibid. 366-367.

[28] Ibid. 371.

[29] Ibid. 366.

[30] Ibid. 362-382.

[31] Ibid. 367.

intentionality becomes more challenging. The first part of chapter 3 –3.1. Computational tools and associated modes of thought– will explain and discuss this change in the nature of design support.

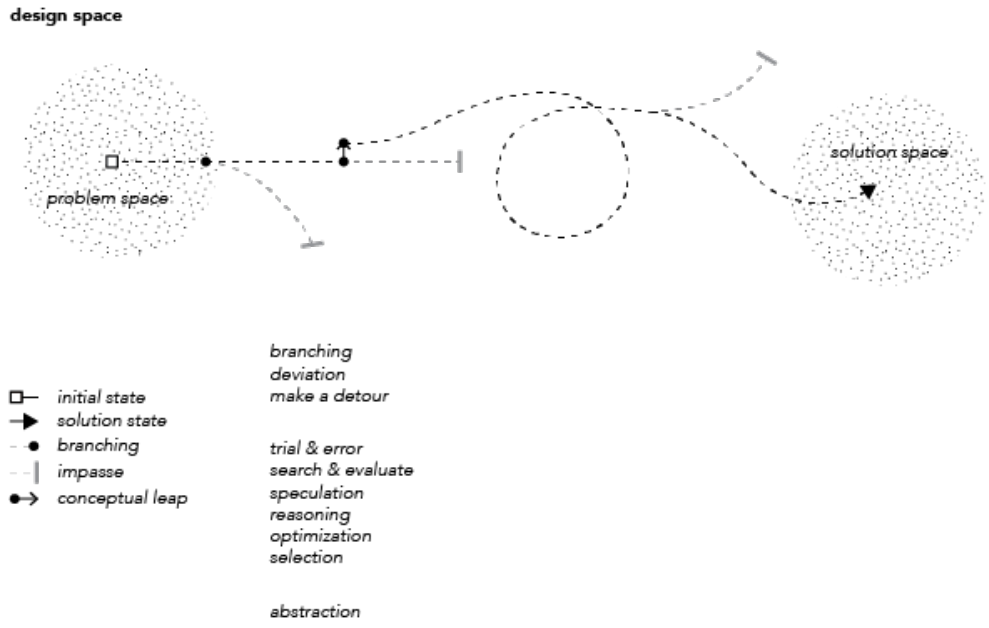


**Figure 1 Trajectory of a conventional design process.** Produced by the author.

## 2.2. The philosophical influence and definition of intentionality

Started with the curiosity to understand the inner works of the human mind, the studies of philosophers like John Searle and Daniel Dennett have deeply affected the research on the relationship between human reason and the computing machine.[32] Intentionality

[32] John Searle. "Intrinsic Intentionality." *Behavioral and Brain Sciences* 3, 1980: 450-456. See also: John Searle. "Minds, Brains, and Programs." *Behavioral and Brain Sciences* 3 (3), 1980: 417-424. And see: John Searle. *Intentionality*, Cambridge: Cambridge University Press, 1983. Daniel Dennett. *Content and Consciousness*, London: Routledge, 1969. See also: Daniel Dennett. *The Intentional Stance*, Cambridge, Mass.: MIT Press, 1987.

as one of the most ambiguous concepts that long occupied philosophy, has a potential place in many other disciplines and research areas which are concerned with the notions such as human mind, human behavior and human relationship with the environment.[33]

Indeed, the etymologic roots and implication of intentionality in the philosophical context are quite complex and highly controversial. Briefly defined as "the property of human consciousness to be 'directed toward' or 'be about' something,"[34] in *Consciousness: The Science of Subjectivity*, Antti Revonsuo, a cognitive neuroscientist and philosopher of mind, gives the traditional definition of the notion of intentionality and its relationship with conscious states of human mind.[35] Revonsuo informs:

> In this philosophical context, the notion "intentional" refers to aboutness or the directedness of mental states at something beyond themselves. A further idea in phenomenology is that all mental states, including consciousness, have a particular structure: Mental states contain a mental act that is directed to its object. This is the bipolar *act–object* structure of consciousness. In any instance of conscious experience, an act (of awareness) must reach outside of itself to some (so-called intentional) objects. This famous phenomenological idea of the fundamental structure of consciousness forms also the basis of neurophenomenology.[36]

In the philosophical field, the most comprehensive work has been done by Edmund Husserl, who puts the question of intentionality at the core of his theory of

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[33] Such disciplines and research areas include but are not limited to society science, philosophy of society, technology studies, anthropology, ethics, linguistics, epistemology, ontology, cognitive science, machine learning, artificial intelligence, cybernetics etc.

[34] Alessandro Duranti. *The Anthropology of Intentions: Language in a World of Others*. UK: Cambridge University Press, 2015: 107.

[35] Antti Revonsuo. *Consciousness: The Science of Subjectivity*. Psychology Press. 2010.

[36] Ibid. 192-193.

phenomenology along with the notions of consciousness, intersubjectivity and embodiment.[37]

In *Husserl's Phenomenology*, Dan Zahavi defines the Husserlian account of intentionality as "an intrinsic feature of consciousness,"[38] which is "not merely a feature of our consciousness of actually existing objects, but also something that characterizes our fantasies, our predictions, our recollections, and so forth."[39] According to Zahavi, Husserl's analysis of intentionality can be defined based on the three elements: the "intentional act," the "intentional object" and the "intentional content."[40] While the intentional act and object reside self-explanatory, Husserl seems mostly concerned with the notion of "intentional content", since according to him, every act possesses an intentional content, which defines the mode or way in which a thought is about an object.[41] Zahavi informs that "it is the intentional content that makes consciousness intentional, furnishing the act with its directedness," in other

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[37] Husserl introduces the term "noema" which is "not an object, but an abstract component of certain types of acts," and believed that conscious acts are "intentionally directed toward objects by means of their noemata." In: David Woodruff Smith and Ronald McIntyre. "Intentionality via Intensions," in *Journal of Philosophy*, LXVIII:18, 1971: 541-542. In this theorization of intentionality, every intentional act has a "noetic content" to which the noema corresponds, in which mental act-process become "directed towards the intentionally held object." According to Husserl, "every act has, as part of its formation, a noematic correlate, which is the object of the act. In: Edmund Husserl*, Ideas: General Introduction to Pure*, trans. W. Boyce Gibson, Collier Books, 1962: 229. As Robert Sokolowski notes: "[T]he noema seems to be whatever is intended by acts of perception or judgement in general, whether it be 'a material object, a picture, a word, a mathematical entity, another person' precisely as being perceived, judged or otherwise thought about." In: Robert Sokolowski, *Introduction to Phenomenology*, Cambridge University Press, 2000: 59. Following Husserl, according to Lukasz Kosowski, intentional matter and intentional quality are antecedent of noema i.e. the noema is the "intentional essence." See: Lukasz Kosowski. *Noema and Thinkability: An Essay on Husserl's Theory of Intentionality*. De Gruyter, 2010: 48.

[38] Dan Zahavi. *Husserl's Phenomenology*. Stanford: Stanford University Press, 2003: 21.

[39] Ibid. 19.

[40] Ibid. 21-22.

[41] Ibid. 22.

words, the act of giving meaning and interpretation becomes possible through the intentional content.[42]

While tending to give priority to the former, Husserl further distinguishes two interdependent and abstract components of intentionality as the "intentional matter" and the "intentional quality."[43] The first component specifies what the experience is about by providing the act with its directedness toward an object, and the second defines the specific type of experience by merely qualifying the reference and not establishing it.[44]

In his book *Approaches to Intentionality*, William Lyons provides the critical approaches to the philosophical conceptions of intentionality in order to develop a multi-dimensional account of intentionality.[45] Lyons claims that intentionality is a "layered developmental concept" whose definition requires a complex approach and therefore it cannot refer to just one thing such as the "aboutness relation," as the etymological roots propose.[46] In *the Anthropology of Intentions: Language in a World of Others*, Alessandro Duranti provides an integrated view of intentionality as developed in his idea of "intentional continuum," in which he acknowledges "variations in levels and degrees of intentional awareness and engagement across any human individual and collective action."[47]

All these definitions of intentionality necessitate human consciousness therefore place the human subject at the center of any intentional act. Such a human-centered account

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[42] Ibid. 22.

[43] Ibid. 23.

[44] Ibid.

[45] William Lyons. *Approaches to Intentionality*. Clarendon Press, 1995.

[46] Ibid. 160.

[47] Duranti. *The Anthropology of Intentions,* 2.

of intentionality can be seen to leave the potentiality of the nonhuman as external and excluded from intentionality. This thesis argues against this anthropocentric understanding of intentionality acknowledging the technological developments in which massive changes occur in computation and intelligent machine design.

If we dismantle Zahavi's account of the Husserlian concept of intentionality, we can come up with an account in which 'agency' is conceived as the intendant that has intentions towards a referent (e.g., an idea, entity, event, situation) and "action" is the way of relating the intendent to that referent.[48] The current chapter will discuss such an agentic account by acknowledging the contributions of both human beings and nonhuman entities and explore the relationship in-between them through the actions in order to propose different degrees and intensities of agencies which are then able to share and delegate intentionality with each other in the design process.

Departing from the Husserlian definition of intentionality towards an agentic account including both human and nonhuman agencies and recalling the previously proposed hermeneutical relationship between the concepts of intentionality and emergence in the field of architecture and design computation, this study proposes that the modes and reasonings provided and sustained by the computational tools alter the solution space of design by means of the emergent properties that these intellectual tools manifest. Then the emergent content provided by these computational tools will inform and extend designers' intentional content as a reflection. Compared to its previous condition, this extended version of the intentional content is then able to include larger amount of representations and ideas about the intellectual tools and their modes and reasoning, so that it can stipulate new ways of thinking and produce novel concepts. (Figure 2)

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[48] Zahavi. *Husserl's Phenomenology,* 23.

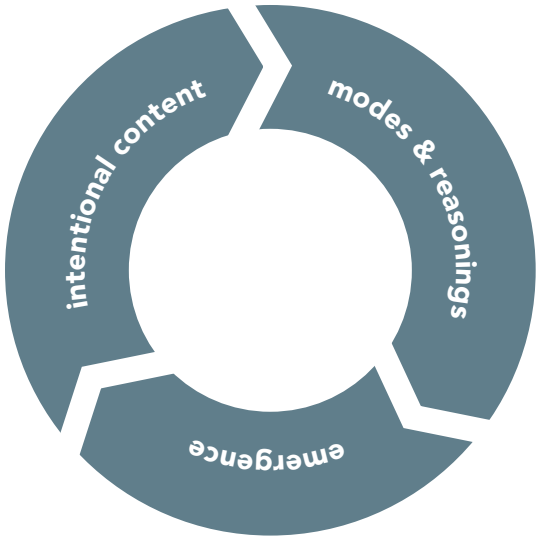


**Figure 2 Diagram showing the proposed hermeneutical relationship in which designers' intentional content is informed and extended by the emergent content as a reflection of the emergent outputs from the computational world.** Produced by the author

### *Intentionality in the field of architecture and design*

Theoretical literature and discourse of architecture lacks a significant discussion or a thorough investigation of the concept on its own terms, mostly because the notion of intentionality is placed at the hard core of discipline as the dominant approach grounds itself in the recognition of the mastermind of the architect.[49] In *Intentions in Architecture,* Christian Norberg-Schulz mentions "intentional possibilities" with reference to Ludwig Wittgenstein.[50] He states:

> In general, we may say that architecture is a human *product* which should order and improve our relations with the environment, it is

[49] However, there are well known approaches that aim to question and transverse the long-established roots of such traditions in architecture such as authorship and architectural program by bringing alternative or even anarchic concepts such as non-program, collective architecture, anonymity etc.

[50] Ludwig Wittgenstein (*Philosophical Investigations,* Oxford, 1953: 193.) quoted in Christian Norberg-Schulz. *Intentions in Architecture.* MIT Press, 1962: 34.

> therefore necessary to investigate how human products are brought forth. Hence we should ask: *What purpose has architecture as a human product?* The functional-practical, the milieu-creating and the symbolizing aspects constitute three possible answers to the question, all of which have to be investigated more closely, and which should, if necessary, be supplemented with other factors.[51]

This presumption that architecture is a pure product of the human (rational) mind is indeed an unquestioned given of architecture that can be seen to be a product of the historical/theoretical conditions defining design intentionality: Once these conditions extend to the contemporary technological/ontological condition of computational design, this conceptualization of design intentionality as sustained in conventional design processes is seen to be displaced for a reconsideration and rehistoricization of design intentionality as embedded within both human and computational agents.

Being critical of the humancentric view on design intentionality, Kostas Terzidis states that in the conventional definition of design intentionality "[o]ne of the intrinsic characteristics of the practice of design is its reliance on ideas that are conceived, generated, or formed within the mind of a lead designer" who is "always exclusively responsible" for design which is regarded as "a particular, irreplaceable and almost sacred" mental process.[52] This condition occupying the hard core of design practice is challenged by the replacement of conventional design tools with ones that computational paradigm brought together.

### *Design intentionality in computational paradigm*

Since Alan Turing's introduction of the notion of a computing machine in the late 1930s, there has been a growing interest in a new paradigm for understanding the mind: a paradigm that treats the mind as a digital computer. The arrival of machine

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[51] Christian Norberg-Schulz. *Intentions in Architecture*. MIT Press, 1962: 22.

[52] Kostas Terzidis. *Permutation Design: Buildings, Texts, and Contexts*. Routledge, 2015: 17.

computation upon our intellectual landscape has had a profound and widespread impact upon research in the many disciplines that are concerned with the study of the mind.[53]

The access to the underlying organization and structure of some biological and natural phenomenon through the vision of philosophy of mind and cognitive science and by means of the developments in technology in general and computer science in specific have deeply affected –even inverted– some neglected accounts in design, namely; organicism, intricacy, complexity, growth, randomness etc., which were previously regarded as irrational, subjectivist, intuitionist, –therefore, unreliable– etc.[54] A re-introduction of these concepts in design research and practice have become possible by means of inquiries into the increased capacity of machine computation, creating as well an intellectual reversal the effects of which can be observed in the altered concerns, methodologies and tendencies. This has led to an expansion of architecture's disciplinary reach and incorporations, and to the emergence of new fields of research.[55] With the developments in technology and the expansion of architecture's disciplinary boundaries, design tools and methodologies have changed shape and altered the intellectual landscape of designers.

It can be noted that the new design tools that technology entail unsettled the long-established anthropocentric account of intentionality. According to Terzidis, by using

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[53] Steven W. Horst. *Symbols, Computation, and Intentionality: A Critique of the Computational Theory of Mind*. London: University of California Press, 1996: 1.

[54] Zeynep Mennan refers to the Modernist mechanic-organic debate that promoted mechanic normativity, charging the organic with a "negative anchorage" within the modern tradition, whose reasoning and justification is associated with "individualistic, subjectivist, intuitionist processes that escape systematic analysis and rationalization." Mennan's claim is that the non standard reforms this epistemic duality and reconciles organic and mechanic by translating once intuitive forms into computational languages. In: Zeynep Mennan. "The Question of Non Standard Form," *METU JFA*, (25:2) 2008: 171-183.

[55] These areas include but not limited to computational design, algorithmic design, parametric design, material computation, virtual reality, responsiveness, machine learning, artificial intelligence, etc.

computational methods, “the designer gets results that are often unintentional, unpredictable, and unexplainable and when that happens a blackbox is set between intention and action.”[56] This means that if the designer doesn’t acknowledge the inner workings of computational tools or computer programs, she/he can only feed the program with inputs and access to the output. With reference to the previous discussions on Bachimont’s theory of a material hermeneutics in general and his account of intellectual tools in specific, such a transfer of human intentionality to the organizational capacity of algorithmic agency creates a rupture in the process of encoding designer’s intentionality with mediation of computation and necessitates reclaiming the interpretative lead of human intentional agency within the constellations in which heterogonous agencies perform various design tasks. The significance of this human interpretative lead in the computational process will be discussed in detail in the following chapter.

In order to discharge from this anthropocentric account of human superiority, this study suggests acknowledging the necessity of the concepts of agency and action so that a shift towards a non-anthropocentric account can be made in order to extend the concept of intentionality towards a comprehensive and distributed account.

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[56] Terzidis. *Permutation Design*, 60.

The term “blackbox” refers to a system in which an immediate observer can only access to its inputs and outputs while the inner workings are unknown. Originally defined in computer science and programming, the theory of black box is adopted by various disciplines such as philosophy of mind, cognitive science, psychology etc. In different conditions, both human behavior or an algorithm can be considered as a blackbox. The opposite concept is called a “transparent box”. Mario Bunge. "A General Black-box Theory", *Philosophy of Science*, Vol. 30, No. 4, 1963: 346-358.

## 2.3. Extension of intentionality through the concepts of agency and action

The vocabulary of agency is brought into the literature through the prominent theories by Gilles Deleuze[57] and Gilles Deleuze and Félix Guattari.[58] For the concern of this study, Deleuzian concept of assemblage is of great value in understanding the human-nonhuman condition in the contemporary era –especially when discussing the human-technology relation. The considerations on agency will provide for a terminology to be later recruited for the assessment of intentionality in computational architecture and design.

### *Beyond the human and nonhuman divide: Deleuze's concept of "expressive agency"*

In his article "Human and Nonhuman Agency in Deleuze"[59], Sean Bowden comprehensively discusses the Deleuzian account of agency, as defined in *The Logic of Sense,* that "can be thought of as compatible with the general features of an affective assemblage approach to agency" by which he claims "Deleuze provides us with the resources for developing an account of human intentional action that is, arguably, compatible with an ontology of assemblages."[60] Bowden claims that "the key idea behind the expressive conception of agency is that actions are in some sense primary in relation to the intentions that animate them."[61] On the human-nonhuman account, we see that the concept of agency in Deleuze is based on a Spinozan ethology in which

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[57] Gilles Deleuze. *The Logic of Sense,* trans. Mark Lester with Charles Stivale, ed., C. V. Boundas. New York: Columbia University Press, 1990: 202-209.

[58] Gilles Deleuze and Félix Guattari. *Anti-Oedipus* (1972) and Gilles Deleuze and Félix Guattari. *A Thousand Plateaus* (1980)

[59] Sean Bowden. "Human and Nonhuman Agency in Deleuze." In: Roffe J., Stark H. (eds) *Deleuze and the Non/Human*. London: Palgrave Macmillan, 2015: 60-80.

[60] Ibid. 74-75.

[61] Ibid. 75.

all being are considered as "a composition of fast and slow speeds, of capacities for affecting and being affected."[62] In this conception, there is no ontological distinction between human and nonhuman or even between artificial and natural, but rather the focus is the "affective capacity" of agents.

According to Bowden there are two main approaches to Deleuzian conception of agency in contemporary literature: In the first approach, the scholars highlight "the nonhuman virtual ground," by affirming the "real agency is essentially nonhuman", and the second approach is formed by those who assign agency to both human and nonhuman, either by suggesting a symmetrical condition or by emphasizing "a distinct kind of human intentional agency."[63]

Bowden exemplifies Peter Hallward's reading of Deleuze for the first approach in which human beings are passive and "virtual creatings" are the real agency which have the capacity to "make new, to transform, change, disrupt, differ."[64] If we develop from Bowden's analytical reading, Bruno Latour's seminal work on *Actor-Network-Theory* can be declared as the strongest defender of this account of agency that considers human and nonhuman in a symmetrical way. Uwe Seifert describes Latour's actor-network theory, which considers "the action relation between humans and machines to be symmetrical, and advocate a kind of anthropology, especially a symmetrical anthropology, which views the roles of machines in human-machine interaction in general to be equated with human roles."[65] Seifert reviews the human-machine interaction and concludes that the discussions also reveal a twofold-outcome about the

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[62] Gilles Deleuze. *Spinoza: Practical Philosophy*. San Francisco: City Lights Books, 1988: 125.

[63] Bowden. "Human and Nonhuman Agency in Deleuze", 60.

[64] Bowden quotes from Peter Hallward. *Out of this World: Deleuze and the Philosophy of Creation*. London and New York: Verso, 2006. Ibid. 60-61.

[65] Uwe Seifert. "The Co-evolution of Humans and Machines: A Paradox of Interactivity," in Uwe Seifert, Jin Hyun Kim, Anthony Moore (eds) *Paradoxes of Interactivity: Perspectives for Media Theory, Human-Computer Interaction, and Artistic Investigations.* Transcript Verlag, 2008:13.

human and nonhuman which indicates no necessity to couple the accounts of 'action', 'interaction', and 'interactivity' only with human agency, and in addition, that such human-nonhuman condition creates an integrated formation that increases and brings together the strongest parts of both human and machines.[66]

Latour looks for effectiveness in human-nonhuman assemblages, while this thesis' concern is on the exploratory capacity of human-nonhuman interaction and how they inform one another and expand their intentional capacity. In this regard, originating from a Deleuzian conception of expressive agency, Jane Bennett's theorization of agency in Political Philosophy which she is more significant and generative for the concern of this study since her approach to the concept of agency doesn't fully flatten and symmetrize the human-nonhuman relationship, on the contrary, Bennett emphasizes the indispensable role of the human agency in an assemblage.[67] By referring to Bennett and Bowden, the thesis will focus on an account of agency "that is compatible with the idea that the human being is both immersed in a world of nonhuman forces and inseparable from affective relations with nonhuman" things.[68]

***Virtuality of agency and Bennett's concept of "thing-power"***

According to Bowden, Bennett proposes that agency should be considered as "distributed throughout a Deleuzo-Spinozan affective assemblage of human and nonhuman 'actants', rather than something explicable only with reference to human will or intentionality."[69] She emphasizes the agentic contributions of nonhuman forces to "cultivate a bit of Anthropomorphism – the idea that human agency has some echoes

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[66] Ibid. 13.

[67] Jane Bennett. *Vibrant Matter: A Political Ecology of Things*. Duke University Press and London, 2010.

[68] Bowden. "Human and Nonhuman Agency in Deleuze", 78.

[69] Ibid. 62.

in nonhuman nature – to counter the narcissism of humans in charge of the world," as "the condition of possibility of human agency."[70] Bennett remarks that:

> A touch of anthropomorphism can catalyze a sensibility that finds a world filled not with ontologically distinct categories of beings (subjects and objects) but with variously composed materialities that form confederate.[71]

Bennett's account of agency is grounded on the Deleuzo-Spinozan approach to human and nonhuman that can be thought of with a symmetrical account of the natural and artificial. According to Deleuze:

> [T]he plane of Nature that distributes affects, does not make any distinction at all between things that might be called natural and things that might be called artificial. Artifice is fully a part of Nature, since each thing, on the immanent plane of Nature, is defined by the arrangements of motions and affects into which it enters, whether these arrangements are artificial or natural.[72]

In parallel with this Deleuzo-Spinozan account, Jane Bennett draws attention to the complexity of forces in human-nonhuman assemblages, and states that: "There was never a time when human agency was anything other than an interfolding network of humanity and nonhumanity; today this mingling has become harder to ignore."[73]

In the conventional human-nonhuman relation, an encounter with the human world can be explained with a distinct divide in which only human has intentionality by being the active subject of any action and nonhuman is the passive object. However, this

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[70] According to Bennett, anthropomorphizing involves the interpretation of what is not human or personal in terms of human or personal characteristics. Bennett. *Vibrant Matter*, 98.

[71] Ibid. 99.

[72] Gilles Deleuze. *Spinoza*, 124.

[73] Bennett. *Vibrant Matter,* 11.

split between human and nonhuman becomes vague when the nonhuman is an invisible force, such as energy, or a virtual thing that resists representation.

On the problem of invisibility and virtuality, according to Bennett, Deleuze's idea of the 'virtual'[74] has a similarity with Foucault's notion of the "unthought,"[75] and accordingly, she states that both thinkers are "trying to acknowledge a force that, though quite real and powerful, is intrinsically resistant to representation."[76] In search for these nonhuman forces that are by nature not directly accessible to human visual content, she acknowledges 'matter-energy' as the smallest unit of an affect for any human or nonhuman beings.[77] She further develops on an account for the contributions of nonhuman actants and insinuates the concept of "thing-power" that signals "the strange ability of ordinary, man-made items to exceed their status as objects and to manifest traces of independence or aliveness" and brings forth "an alternative to the object as a way of encountering the nonhuman world."[78] As Bennett notes:

> [T]here is no necessity to describe these differences [between human and nonhuman] in a way that places humans at the ontological center or hierarchical apex. Humanity can be distinguished, instead as a particularly rich and complex collection of materials.[79]

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[74] For Gilles Deleuze, "virtual" is a term for something that is real but not actual. In: Manuel De Landa. "Assemblages and Virtual Diagrams," *Assemblage Theory.* Edinburg University Press, 2016: 109.

[75] According to William J. Ramp, "Foucault's discussion of the unthought illuminates both the question of intent and that of consequence" by describing "the nineteenth century human sciences as motivated by a quest for the unthought as the hidden or repressed truth of civilization." In: William J. Ramp. "Durkheim and the Unthought: Some Dilemmas of Modernity." *The Canadian Journal of Sociology / Cahiers Canadiens De Sociologie*, vol. 26, no. 1, 2001: 89–115. Accessed in 2018-06-11 from www.jstor.org/stable/3341512.

[76] Bennett. *Vibrant Matter,* xv-xvi.

[77] Ibid. xvi-xvii.

[78] Ibid. xvi.

[79] Ibid. 11.

As a conclusion, Bennett proposes a shift from "a world of nature versus culture" to "a heterogeneous monism of vibrant bodies" by noting that "encounters with lively matter can chasten my fantasies of human mastery, highlight the common materiality of all that is, expose a wider distribution of agency, and reshape the self and its interests."[80]

### *Agentic assemblage: Towards a distributed form of intentionality*

Asking for an intersubjective field, Bennett calls for Maurice Merleau-Ponty's theory of *Phenomenology of Perception,*[81] which according to her, is "designed to avoid placing too much weight on human will, intentionality, or reason," and instead, concentrating on the "embodied character of human action.[82] In opposition to an account of human-centered intentionality, she emphasizes a theory of distributive agency that does not place a human agency at the core of an effect, while at the same time "does not deny the existence of that thrust called intentionality, but it does see it as less definitive of outcomes."[83] Bennett affiliates the concept of agency with the terms 'efficacy', 'trajectory' and 'causality'.[84] Firstly, agency has efficacy that "points to the creativity of agency, to a capacity to make something new appear or occur;" secondly, it is attached to the idea of a trajectory, a directionality or movement away from somewhere even if the toward-which it moves is obscure or even absent," and thirdly it has causality.[85] She notifies:

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[80] Ibid. 122.

[81] For Bennet's reference to Maurice Merleau-Ponty see ibid. 29-30.

[82] Ibid.

[83] Ibid. 31-32.

[84] Ibid. 31.

[85] Ibid. 31-33.

> [A]n actant never really acts alone. Its efficacy or agency always depends on the collaboration, cooperation, or interactive interference of many bodies and forces. A lot happens to the concept of agency once nonhuman things are figured less as social constructions and more as actors, and once humans themselves are assessed not as autonoms but as vital materialities.[86]

She continues offering that: "Alongside and inside singular human agents there exists a heterogeneous series of actants with partial, overlapping, and conflicting degrees of power and effectivity."[87] Bennett's account of agency is significant for this thesis since she addresses a complex and distributed form of intentionality which values the contributions of both human and nonhuman agencies yet arguing for a distinct type of human responsibility.[88] According to Bowden, Bennett's work is a timely reminder that "overly-simplistic conceptions of human agency are both descriptively inadequate, insofar as they tend to overlook the complexity of situations in which human action is produced."[89]

***Concept of action | agentic action***

> [A]ctions are intrinsically directed, or inhabited by the intentions that direct them, even if the articulation of the content of this intention is inseparable from the action's unfolding in the expressive dimension proper to it.[90]

In the early 90s, Madeleine Akrich and Bruno Latour attempted to create a vocabulary that leads to a distributed mode of agency in which the aim is to increase "the

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[86] Ibid. 21.

[87] Ibid. 31-33.

[88] Bowden. "Human and Nonhuman Agency in Deleuze", 62.

[89] Ibid. 64.

[90] Bowden refers to Charles Taylor. "Hegel and the Philosophy of Action", in *Hegel's Philosophy of Action*, eds., L. S. Stepelevich and D. Lamb. Atlantic Highlands, NJ: Humanities Press, 1983: 2-9. Ibid. 76.

performances of actors" and "the efficiency of the assembly."[91] They propose to describe the "program of actions and the complete list of substitutions it entails."[92] The actions and agents exist in a "setting" that is "a chain of H(umans) and N(onhumans), each endowed with a new competence or delegating its competence to another."[93] (Figure 3)

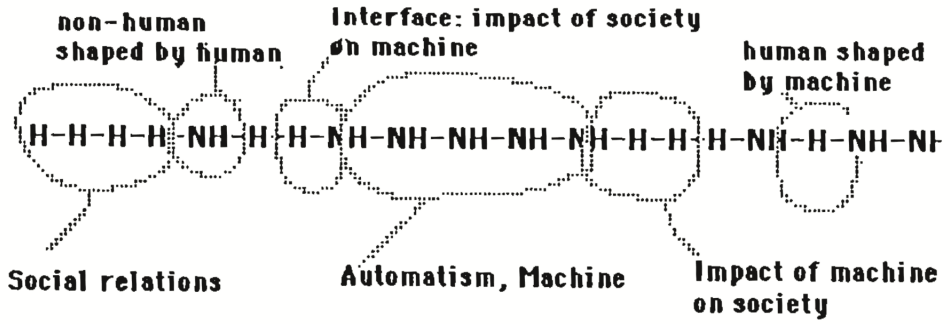


**Figure 3 Akrich and Latour's chain of Humans and Nonhumans.** Source: Madeleine Akrich and Bruno Latour. "A Summary of a Convenient Vocabulary for the Semiotics of Human and Nonhuman Assemblies," in Wiebe E. Bijker and John Law (eds) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. MIT Press, 1992: 263.

By locating the difference and repetitions in the chain, variations of human-nonhuman relations can be read. It is evident that the preceding component passes some of its properties to the next one: When a nonhuman is preceded by a human agency, Akrich and Latour call it as "nonhuman shaped by human," and on the other way around, human can also be shaped by machine.[94]

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[91] Madeleine Akrich and Bruno Latour. "A Summary of a Convenient Vocabulary for the Semiotics of Human and Nonhuman Assemblies," in Wiebe E. Bijker and John Law (eds) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. MIT Press, 1992.

[92] Ibid. 261.

[93] As Madeleine and Latour continue: "in the chain one may recognize aggregates that look like those of traditional social theory social groups, machines, interface, impact." Ibid. 262.

[94] Ibid. 263.

While the expression of "human shaped by machine" is quite naïve and reductionist to include the complexity of the interactivity between nonhuman and human, the transmission from human to nonhuman is more familiar and acknowledgeable to us. The authors leave the discussion on the human-nonhuman interface rather incomplete. In one of the following parts of this chapter (2.5. A visualization of intentionality) the conditions and intensities of such relations will be discussed in detail.

To bypass the linearity of the chain, Akrich and Latour come up with the term "re-inscription" which is a feedback mechanism that means "the redistribution of all the other variables in order for a setting to cope with the contradictory demands of many antiprograms."[95] Authors claim that through re-inscription, the linear chain of human-nonhuman agency can be "folded" on itself and create complexity in the setting.[96]

Keeping the vocabulary of Akrich and Latour aside, their diagram brings forth questions such as: Can a human-nonhuman heterogeneity create a social assembly? Can homogenous nonhuman settings generate conditions other than machine automation as Akrich and Latour proposes?[97]

Werner Rammert, Professor of Sociology and Social Studies of Technology, problematize the conventional conception of action that is associated closely with the anthropocentric account of human intentionality and reflected in the master-slave form of relation between human, who possesses action, and his instrument.[98] In this classical definition, action means "moving the body, making something, showing initiative,

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[95] Ibid. 262.

[96] Ibid.

[97] Ibid. 263.

[98] Werner Rammert. "Where the action is: Distributed Agency between Humans, Machines, and Programs," in Uwe Seifert, Jin Hyun Kim, Anthony Moore (eds) *Paradoxes of Interactivity: Perspectives for Media Theory, Human-Computer Interaction, and Artistic Investigations.* Transcript Verlag, 2008: 62-91.

bringing about an alteration by force, and expressing oneself thereby."[99] Therefore, Rammert asserts that continuation of such definition of action neglects the nonhuman agency and lead to an unproductive and incomplete understanding of technological developments in which massive changes occur in intelligent machine design and many agents included in the creation of it.[100] Acknowledging the difference between software agents from human actors, he points out that these technological agents are also different from the "classical machines and media" with their particular capacities of being active and interactive.[101] Despite the fact that they are human-made, these technological objects can be called as agents, since they are quite peculiar in the sense that, firstly, they are "equipped with a feedback mechanism," therefore they are fundamentally different from the previous systems that are completely blind and passive.[102]

In order to bring forth a productive and sophisticated definition of agency, Rammert focuses on the concept of action by examining the relationship between human and nonhuman.[103] He further points out the significant changes in the field of human-technology relations that waits to be conceptually revisited and turned into a field including more active agents and agencies.[104]

One of the alterations in the human-technology interface is the shift from "instrumental causality" to "interactive contingency," i.e. the shift from the hierarchical instrumental actions, in which people is the only source of activity, toward relations of interactivity

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[99] Ibid. 63.

[100] Ibid.

[101] Ibid.

[102] Ibid. 67.

[103] Rammert addresses these questions: Where is the action, what is the unit of action, and what kinds of action are there? Ibid.

[104] Ibid. 64, 74.

in which "heterogeneous sources of activities" are included.[105] Another change is the fragmentation of action, i.e. delegation of some actions to multiples of pro-active and cooperative agents that mimic human agency and perform parts of action in the background. [106] As he defines:

> From a technological view, agents are particular computer programs. They are written with the intention that software agents can execute actions like human agents. This means that actions are delegated to them. The agents divide and delegate the action among other agents. They cooperate with one another, thereby moving, taking the initiative and addressing others. [107]

The last point that Rammert indicates is the occurrence of hybrid constellations that actions emerge out of and that are made of a hybrid mix of human agency and advanced technologies, such as machines and programs.[108]

Responding to these changes in human-technology relation, Rammert proposes an account of agency that includes "different levels of human agency as well as different levels of technologies in action."[109] Therefore, drawing attention to the changing role of technologies from passive instruments toward active agents and mediators, he suggests replacing the narrow concept of instrumental action with a broader concept of "inter-agency" that includes "interaction" between human agency, "intra-activity" between technical agents, and "interactivity" between human and nonhuman.[110] Among these three types of agency, interactivity proposes a cross-relation between

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[105] Ibid. 65.

[106] Ibid.

[107] Ibid. 67.

[108] Ibid. 65.

[109] Ibid.

[110] Ibid. 71.

human-nonhuman interface thereby proposing the most significant relationship in a heterogenous hybrid setting.[111]

On the notion of intentionality, Rammert criticizes the anthropocentric account of human intentional agency and states that it is an outcome of "an efficient strategy of teaching and tradition-building to attribute a thought act to one author because it reduces cognitive and social complexity."[112] He explains this idea with the act of writing that "arises as a distinct action, because it is sectioned off, retrospectively emphasised, and ascribed to a single unit, an actor or an author," i.e. "the very idea" of the product of the act –a book in this case– is attributed to a single human actor.[113] Despite the uniqueness of the act of writing, it never happens as a single action, it is rather occurring as externalization of accumulation and connected with a lot of preceding thought actions of other thinkers and writers.[114] Rammert continues:

> The act of writing interrupts this continuous chain of acts and turns it into the unique philosophical thought action that changed the world or at least the world view. The act of writing the sentence down by one single actor is emphasised, but both, the flux of thought acts before and the sequences of actions afterwards, such as printing, distributing, reading, teaching and learning, were put into brackets and neglected.[115]

In opposition to the conventional account of intentionality in which a single human actor is the source and unit of action, Rammert's account is significant as it extends the concept of intentionality with the notions of agency and action which now can form

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[111] Ibid.

[112] Ibid. 78.

[113] Ibid. 77.

[114] Ibid. 78.

[115] Ibid.

hybrid constellations made of heterogeneous units of agencies with different intensities and conditions.

## 2.4. Intensity and condition of agency

Instead of Latour's flattened concept of agency, Rammert considers distributed agency as a "concept beyond human action and technical means"[116] and proposes a multi-level model in order to recognize the action-distribution by "a hybrid mix of agencies like people, machines and programs" instead of "the dual concept of human action and machine's operation."[117]

### *Intensity of agency: Causality, contingency, intentionality*

On the level of *causality*, there is a weak intentionality whose existence is based on a performative aspect.[118] In the lowest form it can be assigned with a task of selection from pre-selected options, and at highest, it may have a capacity to self-generate actions.[119]

On the level of *contingency*, a capacity to act in a different way and to choose between options is required. Contingency here denotes for a negotiation of agencies and an adaptation by human as well as program is expected when there is a change in the course of things "in such a way that its consequences are not immediately transparent

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[116] Ibid. 63.

[117] Werner Rammert. "Distributed Agency and Advanced Technology. Or: How to Analyze Constellations of Collective Inter-Agency," Technical University Technology Studies. Working Papers. TUTS-WP-3-2011: 2.
Accessed in 2018/04/22 from https://www.ts.tu-berlin.de/fileadmin/fg226/TUTS/TUTS_WP_3_2011.pdf

[118] Rammert. "Where the action is", 75.

[119] Ibid. 77.

and accountable for the others."[120] Rammert exemplifies this level of intentionality with the Turing Machine where it becomes almost impossible to detect whether the human or computer agency performs the action. [121] On the level of *intentionality*, an intentional action is expected. As extensively discussed at the beginning of this chapter, this kind of agency is allocated to an intentional human agency. Software agents do not have intrinsic intentional consciousness; however, they can be programmed with an "intentional vocabulary." [122] As Rammert underlines:

> Software agents cannot cooperate with others in a bodily manner and trust them under the explicit belief of augmenting their chances to reach a common goal. However, they can be equipped with an intentional vocabulary by which they really coordinate and communicate their activities as human actors do, with similar semantics.[123]

This new semantics that software agents demanded requires a reconsideration on the roles of human and nonhuman in order to create a common ground for communication.

### *Condition of agency: Intrinsic and derived intentionality*

In the conceptualization of the condition of intentionality, the study will refer to the discussions of Steven Horst, who is a professor of philosophy of mind in cognitive science. In *Symbols, Computation, and Intentionality: A Critique of the Computational Theory of Mind*, he discussed the approach of Kenneth Sayre and John R. Searle[124] on

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[120] Ibid. 76.

[121] Ibid.

[122] Ibid.

[123] Ibid.

[124] Searle proposes: "(1) Intentionality in human beings (and animals) is a product of causal features of the brain I assume this is an empirical fact about the actual causal relations between mental processes and brains It says simply that certain brain processes are sufficient for intentionality. (2) Instantiating a computer program is never by itself a sufficient condition of intentionality. The main argument of this paper is directed at establishing this claim. The form of the argument is to show how a human agent could instantiate the program and still not have the relevant intentionality. These two

the human-nonhuman relationship with reference to the Computational Theory of Mind (CTM).[125]

The two modes that intentionality can be owned are intrinsic and derived: Human agency has intentional states which have *intrinsic intentionality*, and according to Horst, "symbols have it only *derivatively*."[126] Intentionality in computer symbols is "derivative or conceptually dependent because it refers back to the sense that is applied to cognitive states."[127] Horst states that Sayre puts more emphasis on the role of human agency in computer or "the role that computer users and programmers play in imbuing symbols in computers with meaning and intentionality," and denies that computers exhibit any kind of intentionality; on the other hand, Searle admits a kind of intentionality that is derived from human agency.[128] According to Horst:

> Searle has in mind something like this notion of conceptual dependency of symbolic intentionality […] "meaningfulness" and "intentionality" of symbols in computers is "dependent" upon the intentions of users and programmers.[129]

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propositions have the following consequences (3) The explanation of how the brain produces intentionality cannot be that it does it by instantiating a computer program. This is a strict logical consequence of 1 and 2. (4) Any mechanism capable of producing intentionality must have causal powers equal to those of the brain. This is meant to be a trivial consequence of 1. (5) Any attempt literally to create intentionality artificially (strong AI) could not succeed just by designing programs but would have to duplicate the causal powers of the human brain. This follows from 2 and 4." Searle. "Minds, Brains, and Programs", 417-457.

[125] Horst. *Symbols, Computation, and Intentionality.*

[126] Ibid. 64.

[127] Ibid. 72.

[128] Ibid. 72-73.

[129] Ibid. 72-73.

Following Searle, Horst claims that "an object has *derived* intentionality just in case it received or inherited its intentional properties from another object having intentional properties by way of some causal connection."[130] Correspondingly:

> The intentionality of symbols in computers, according to Searle, can be explained in just the same fashion. Symbols in a computer, like marks on paper or vocalized sounds, are not intrinsically meaningful. Meaning is *imputed* to symbols by some being who has intentional states. […] In the case of symbols in computers, it is the designer, programmer, or user. Intentional states have intentionality *intrinsically*; symbols have it only *derivatively*.[131]

Following the discussions, it can be noted that when the agency becomes a programmed agency, there occurs a derived intentionality as in the case of software agents that are programmed with an intentional vocabulary. This means that intentionality can be distributed and embedded in nonhuman agencies as well as human beings, and it may exist at different levels and intensities.

### 2.5. A visualization of intentionality

> [A] genius will be defined as genius not because it is human but rather because it behaves like a genius.[132]

Following the present delineation of the theoretical framework on the conception of intentionality and its augmentation with the concept of agency and action, the study attempts to visualize graphically a spectrum of intentionality with respect to Werner Rammert's multi-level model of agency and Steven Horst's conditions as intrinsic and derived intentionality.[133] The spectrum aims to show the relations between levels of intentionality and agency conditions. (Figure 4) The main scale that is employed here

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[130] Ibid. 64.

[131] Ibid.

[132] Terzidis. *Permutation Design*, 18.

[133] Horst. *Symbols, Computation, and Intentionality.*

is the *intensity* of the agency, and the three levels of gradation are *intentionality, contingency* and *causality*. The second scale is the condition of agency on whether intentionality is *intrinsic* or *derived*.

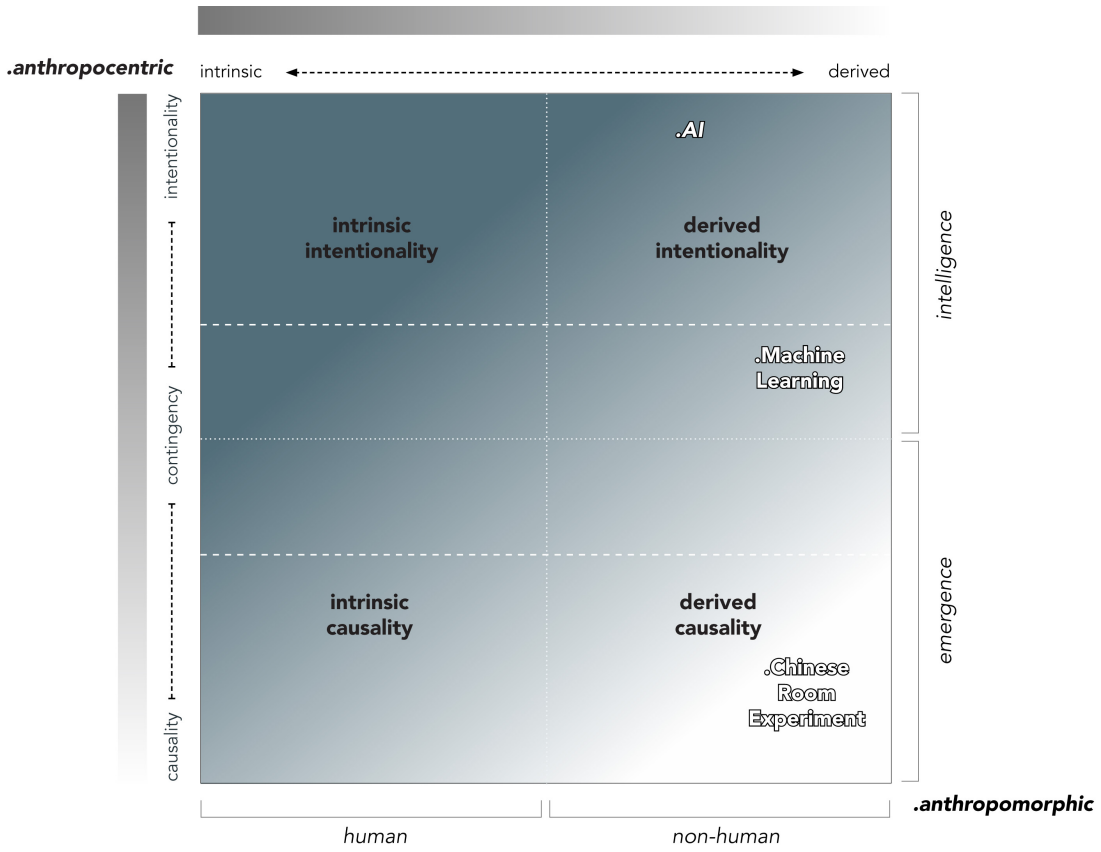


**Figure 4 Spectrum of intentionality showing the relations between different levels of intentionality and human-nonhuman agencies.** Produced by the author.

## [def] intelligence

On the upper left, there is *intrinsic intentionality* which could be defined as the purest and most intense form of intentionality. Intentional human agency can be placed at this end.

The upper right field is *derived intentionality* that can be conceptualized as the nonhuman account in which intentionality is strong yet *indirect*, as it is by nature derived from some human intentional agency. While machine learning can be exemplified as a rather moderate version, Artificial Intelligence (AI) can be stated as the strongest recognized form of this mode in which the intentionality is distinct, yet, derived from some human agency and encoded in a new form of an intelligent agency.

In both forms of intentionality, the common generator is the *intelligence* –either intrinsic or derived– which has a great potential to affect other agencies.

**[def] emergence**

On the lower part of the scale, the two other modes of intentionality can be defined with *emergence* as their common *causal* property. The rather unpredictable or causal condition questions the relationship between intentionality and emergence which, on the surface, appears to be a polarity or an epistemic opposition. The seemingly opposite yet hermeneutically related condition of these two concepts makes the investigation more interesting and urgent in order to comprehend the contemporary condition of human and nonhuman relation that is challenged by the computational tools and modes in architecture and design.

On the lower right side, the occurring condition is *derived causality* which is previously mentioned by Horst as "causally derived intentionality."[134] Symbols that are used in codes and programs have this kind of intentionality whose origin of intentionality is derived from a designer or programmer by way of some causal

[134] Ibid. 64.

connection.[135] Searle's Chinese Room thought experiment[136] can be an instance of this form of intentionality. According to David Cole, the simple arguments put forth with the Chinese Room are at "the service of highlighting the serious problems we face in understanding meaning and minds."[137] As Cole indicates:

> The many issues raised by the Chinese Room argument may not be settled until there is a consensus about the nature of meaning, its relation to syntax, and about the biological basis of consciousness. There continues to be significant disagreement about what processes create meaning, understanding, and consciousness, as well as what can be proven a priori by thought experiments.[138]

At the lower left field of the spectrum, an ambiguous condition occurs. A new form of intentionality is revealed which can be named as *intrinsic causality* in which there is an intrinsic causal mechanism that requires an investigation. Such kind of intentionality can be claimed to exist in nonhuman natural forces and their swarm behaviors whose inner mechanisms were previously unknown to us.

The aim of this chapter was to define and then unfold the intentional content, which was established as the starting point of a hermeneutical circle within the scope of this thesis. Now that we have a multi-layered conceptualization of intentionality, (Figure 5) we can attempt to confront a much harder problem of intellectualizing its relationship with the concept of emergence.

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[135] Ibid.

[136] Proposed by John Searle in 1980, Chinese room argument is a thought experiment aiming to show that "the computer is not merely a tool in the study of the mind, rather the appropriately programmed computer really *is* a mind in the sense that computers given the right programs can be literally said to *understand* and have other cognitive states." Searle. "Minds, Brains, and Programs", 417-424.

[137] David Cole. "The Chinese Room Argument", *The Stanford Encyclopedia of Philosophy* (Winter 2015 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2015/entries/chinese-room/>.

[138] Ibid.

Therefore, the next chapter will discuss how the emergent content provided by computational agency informs and extends designer(s)' intentional content with reference to the alterations in design modes and reasonings by elaborating on the change in "material instruments and supports"[139] -specifically the emergent properties of computational tools-, for the exercise of design thought that unbalances the dominant human-centered condition of agency.

[139] Bachimont. "Formal Signs and Numerical Computation", 366.

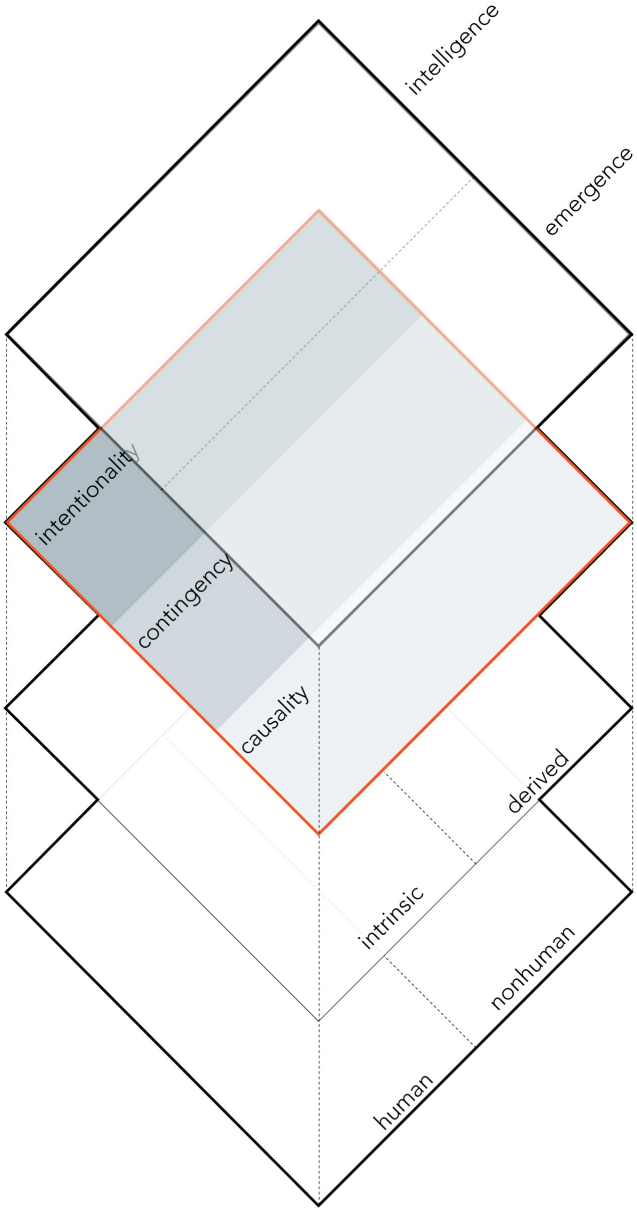


**Figure 5 Multi-layered conceptualization of intentionality.** Produced by the author.

# CHAPTER 3

## EMERGENT CONTENT: THE GENERATIVE ROLE OF COMPUTATIONAL TOOLS (IN)FORMING DESIGN INTENTIONALITY

The previous chapter revealed that intentionality can be conceptualized as a spectrum in which multiple conditions and different intensities of agency exist. In the present chapter, such a consideration will be reflected back on the field of design considering as well the alterations in design tools, modes and reasonings that the computational paradigm entails. If the gap created in-between the world of design and the world of computation can be argued to be filled by the developments in technology, one may notice that the conventional definitions and understandings of some concepts need to be revisited and reconceptualized according to the structure (i.e., properties and capacities) of design tools that technology brings about, among which the emergent properties that draw a larger interest for this study. Therefore, in order to correspond to the question of design intentionality when using computation in architecture and design, the notion of emergence –a concept that, with the digitalization of mathematical algorithms, has entered the world of design and began to connote an exploratory and generative approach to the uncertainties and indeterminacies of computation– will be discussed in depth with reference to the emergent properties of computational design tools. Such inquiry will show that these tools allow designers to interact with what Manuel de Landa calls as an expanded "possibility space" whose structure can be defined by "topological invariants like dimensionality, connectivity, and distribution of singularities" through which design action is extended towards an

unknown and unpredictable world in architecture which the emergent properties of these tools facilitate.[140]

Recalling Bruno Bachimont's discussion on the material instruments and supports, a change in design tools can be argued to enable the expansion of possibility space and emergent content and to decenter the dominant human-centered condition of agency by informing and redefining designers' intentional content through recursions and continuous feedbacks. Such an interpretative correlation between the concepts of intentionality and emergence enables the recruitment of what Bruno Bachimont calls as 'material hermeneutics' in the field of computational architecture. [141]

### 3.1. Computational tools and associated modes of thought

In order to develop an interpretive understanding between the concepts of intentionality and emergence and the corresponding roles of human and computational agencies, this chapter aims first to clarify Bachimont's account of 'intellectual tools' and 'material supports' as introduced in his theory of 'material hermeneutics'.[142] Then the concept of emergence and emergent properties of computational tools will be examined with reference to Manuel De Landa who is a prominent reader of Gilles Deleuze.[143] And finally, the discussion will be extended on the role of algorithmic agency which opens up a potential space that is otherwise inaccessible territory for the mutual exploration towards generative and creative uses of abstract mathematical procedures and data structures in computational architecture.

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[140] De Landa. *Assemblage Theory,* 122.

[141] Bachimont. "Formal Signs and Numerical Computation", 362-382.

[142] Ibid.

[143] Manuel De Landa. "Emergence, Causality and Realism." *The Speculative Turn: Continental Materialism and Realism.* Levi Bryant, Nick Srnicek and Graham Harman (eds). Melbourne: re.press, 2011: 381-392.

Before moving to the concept of emergence and emergent properties of computational tools, the relationship between design action and design tools needs first to be outlined through explaining the concept of 'graphic reason' introduced by Jack Goody, and that of 'computational reason' proposed by Bruno Bachimont.

***Graphic reason and computational reason***

> All human reasoning is accomplished by means of certain signs or characters. It is not only the things themselves, but also the ideas of the things that the intellect cannot, and should not, always observe in a distinct way; this is why one places signs in their place, in order to abbreviate . . . Therefore, names have been given to contracts, figures, to the various kinds of things, as well as signs to numbers in arithmetic, and to sizes in algebra, so that if experience and reasoning one day allows us to discover certain things, one can consequently combine in all confidence the signs of one with the signs of others.[144]

In the architectural design process, subjective-intuitive-artistic processes are either stimulated or realized with a trust grounded on 'visual knowledge'.[145] On the visual aspect of the diagram, which is a significant design tool for architects facilitating the visualization of ideas or particular problems, De Landa states that "it is the specifically visual aspect of the diagram which is emphasized, for example, the ability of geometric representations to rapidly convey to a problem-solver some of the crucial aspects defining a particular problem, and hence, to suggest possible solutions."[146]

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[144] Bachimont quotes Gottfried Wilhelm Leibniz to explain human reasoning and the algebraic formalism of Leibniz. Bachimont. "Formal Signs and Numerical Computation", 363.

[145] Manuel De Landa. "Deleuze, Diagrams, and the Genesis of Form." *Amerikastudien / American Studies*, vol. 45, no. 1, 2000: 33. Accessed in 2018/07/23 from *JSTOR*, JSTOR, www.jstor.org/stable/41157534.

[146] Ibid.

Based on his work on the act of writing, Jack Goody proposes the notion of 'graphic reason' to explain how a change in the technical instruments effects the act by illustrating "the role of writing in the emergence of certain cognitive operations."[147] Bachimont notes that "work on writing has made it possible to show that the technical innovations that have marked its history have had direct consequences on the thinkable (and not only on the thought)."[148] For example, he mentions that when compared to the act of speech, the act of writing enables the de-linearization of speech by proposing a spatial synopsis that supports "the recognition of relations and properties that remain untraceable in the linear succession of the temporality of speech" by making "relations visible that are not perceivable when listening to speech." [149]

By referring to Goody's reading on the act of writing, Bachimont deduces that different types of reasonings are encouraged by the "differences proceeding from distinct technical instrumentalizations,"[150] such that computational reason is encouraged by the effect created with the advent of machine computation into the field of architecture and design that has led to "the technological mutation of intellectual tools."[151] Such mutation of intellectual objects may precede the creation of "non-sense but also new and unanticipated symbolic configurations whose interpretation enables the emergence of new thoughts and conceptions, just as one can understand sentences one has never said or heard."[152]

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[147] Bachimont. "Formal Signs and Numerical Computation", 368.

[148] Ibid.

[149] Ibid. 369.

[150] Ibid. 368.

[151] Bachimont quotes Gottfried Wilhelm Leibniz to explain human reasoning and the algebraic formalism of Leibniz. Ibid. 363.

[152] Ibid. 365.

Prior to the change in the nature of the support of inscription, Bachimont suggest a shift from 'graphic reason' to 'computational reason.'[153] By drawing attention to the paradoxicality of the condition, the interdependence of thought on a technical principle -the material conditions of reason-, Bachimont states that "the thinkable does not depend on the technical environment of the intellect, even if, in a contingent way, what is effectively thought can be affected by the material conditions of reason," i.e., an act that technically only depends on itself is also dependent on a technical principle for its effective augmentation.[154]

A conceptualization on the relationship between computational tools and design intentionality requires a deeper consideration on the nature and structure of these tools in order "to understand how these computational or numerical tools put the combinatorics of symbols at the service of the power of the invention of sense."[155]

***Role of interpretation***

In his phenomenological approach to material instruments and supports, Bachimont locates interpretation at the core of his theory of knowledge. Zeynep Mennan in her reading of Bachimont, points out to the necessity of human interpretation for an integration of formalism (induced by computational reason) and intuitionism.[156] By focusing on the material support of interpretation, Mennan proposes to "bridge the gap between the unintelligibility of numerical inscriptions i.e., notations" and

[153] Ibid. 368.

[154] Ibid.

[155] Ibid. 366.

[156] Mennan. "Mind the Gap", 33-42.

representations of computational processes, and human intuition through the act of interpretation.[157]

In his critique of formalism in computational reason, Bruno Bachimont conceives formalism and intuitionism as two distinguishable positions.[158] His central argument is that the sign and the presence of symbols are the conditions for reasoning to be carried out whether it is intuitive or formal, content being the distinguishing factor; either it is "present" (intuitionism) or "one can do without it" – blind to content (formalism).[159] He notes:

> The material type of the inscription medium and the transformation and manipulation properties that characterize it are correlated to a particular type of rationality and way of thinking. Like the graphical reason proposed by Jack Goody in the past to characterize the cognitive consequences of writing, we propose the notion of computational reason to characterize the way of thinking that would be associated with digital inscriptions.[160]

Bachimont claims that computational tools create a rupture in the history of tools with their inventive power in thought processes, similar to the one that is produced by "the act of writing."[161] He further notes that:

> By spatializing speech, writing de-linearizes it, and enables the observation of the content in the two-dimensional spatiality of the page. Nevertheless, the written loses the intonations, prosody, and emotional markers, of which the memory can retain a more or less true recollection. If the written increases the intelligibility of speech

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[157] Ibid.

[158] Bachimont. "Formal Signs and Numerical Computation", 362.

[159] Ibid. 364.

[160] Bruno Bachimont, "*Théorie du support: du support numérique à la raison computationnelle. Prolégomènes et critique*", 2006. Accessed in 27/06/2018 from http://www.utc.fr/~bachimon/Approchephilosophique.html

[161] Bachimont. "Formal Signs and Numerical Computation", 366-367.

> by making it visible, then it also removes levels of comprehension. The written gives us the material to think differently, to think something else, and to bring about new intellectual tasks and objects.[162]

Referring to the shift that the computational paradigm marks in the history of the intellectual tools that help us think, Bachimont claims both writing and computation are "formal" if their material and physical nature is kept without the mediation of interpretation.[163] Then, a major problem arises regarding the formalism of computational tools when "the symbols appearing on the computer" can be taken "too literally" since "formalism is not systematically linked with content."[164] But the same problem may end up in "new and unanticipated symbolic configurations whose interpretation enables the emergence of new thoughts and conceptions" since the intelligibility of the outputs of those computational processes is not predetermined.[165] The contribution of these calculated representations originates from the indeterminacy and unpredictability of computation in the process of interpretation.

Following Bachimont's discussion and extending it to computational design research, Zeynep Mennan points out the epistemological gap in-between computational logic and human intuition consequent to the shift in the philosophical, methodological and representational dimensions.[166] Mennan calls attention to the "change in the nature of the support of inscription" which is produced by the computational paradigm and induced by the complexity it creates.[167]

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[162] Ibid. 367.

[163] Ibid. 366

[164] Ibid. 365.

[165] Ibid.

[166] Mennan. "Mind the Gap", 33-42.

[167] Ibid. 33, 34.

The problem with computational tools in design research arises when the resulting formalism cannot be reconciled with interpretation. Mennan emphasizes the indispensable role of interpretation with reference to Bachimont's theory of material hermeneutics in which "the possibility of a material support's encounter with an interpretation" is explored.[168] As she continues, 'material hermeneutics' aim to reconcile "the productivity and efficiency of formal representations" with "new interpretive practices that surpass conventional hermeneutical ones."[169]

### *Computational tools as reinvention of design thought*

The hypothesis of Bachimont's theory of support is that the material properties of the support of inscription is the condition of the intelligibility of the inscription by which "technology proposes new synthetic configurations to the apprehension of the intellect."[170] Bachimont questions the emerging condition and asks how this rupture in the nature of the material support with technology altered the way we think and "produce new intellectual objects, and how we elaborate concepts which would remain inconceivable without such a numerical mediation."[171] He conceptualizes the computational support as an intellectual tool that computer science and "the digital" entail, whose nature and properties help designers to think in different ways and cause the emergence of new material objects.[172]

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[168] Ibid. 38.

[169] Ibid.

[170] Bachimont. "Formal Signs and Numerical Computation", 371.

[171] Ibid. 367.

[172] In Bachimont's account, 'the digital' corresponds to the formal systems covering the totality of the calculable, that is to say information processing operations performed by a machine. The digital inherits properties of the formal, namely to handle formally discrete signs. Therefore, any data, in numerical form, is potentially derived from a calculation. And, a 'material object' is not a physical or tangible entity, rather it is the correspondence of a possible action, it is the matter or medium.

In the field of architecture and design, two distinct approaches to computational tools and associative technologies can be registered: One line of theorizing considers computational tools as prostheses to thought processes i.e., an extension to design thinking, and the second line as a reinvention of design thought.[173] Bachimont's theory of 'material hermeneutics' enables designers from both approaches. His account of computation can be viewed as both an extension of the human mind and a means that facilitates novel ways of thinking in which design thought is reinvented and exceeds the former. Accordingly, he states:

> Numerical technologies inscribe themselves in the movement of the externalization and prostheticizing of thought so that intellectual operations can be consigned and confined to those material tools and instruments, thus unburdening thought and enabling it to turn its attention to other things. However, by being confined to material instruments and supports, intellectual tasks change their nature, and the intellect, when reappropriating the result, finds something different from what it would have found had it taken on these tasks itself.[174]

Despite the fact that calculation grounds itself on the scientific and technical nature, Bachimont notes that the consequences resulting from the extensive use of computational tools in diverse fields of human activity are still difficult to assess, and he calls for the necessity to provide users of computational tools with the relevant interpretive paths in the process, since according to him, only human agency can interpret the complexity. [175] Bachimont further notifies that:

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[173] A consideration of computational tools as an extension to design thought reflects itself in a human-centered account in which design intent is grounded in human agency and computational tools are implemented to perform that intention rather than having a decisive role. This thesis is interested in exploring encounters and affective assemblages in which emergent properties of algorithmic agency are considered as a means to reinvent design thought that leads to unprecedented and novel ideas.

[174] Bachimont. "Formal Signs and Numerical Computation", 366.

[175] Ibid.

> [O]ne should not assume that the technological mutation of intellectual tools necessarily leads to a supplementation, to an extension of our cognitive field. It could also result in a deficiency of intelligibility, in a loss of sense, a disorientation. The possibilities opened up by a technological mutation, before being actualized, could result in a lack. […] numerical mutation is neither a progression nor a regression, but a mutation that imposes itself on us even if we are its author.[176]

Within the scope of this thesis, Bachimont's theory of support and his differentiation of computational reason and graphic reason contribute extensively to the discussions in order to understand the potential role of computational tools in conceptualizing design intentionality. His theory of 'material hermeneutics' establishes the relationship between the concept of intentionality and emergence.

To illustrate the difference between graphic and computational reason, the idea of the barcode as a widely used design example from everyday life can be introduced. As an advanced form of classical linear barcode system, Quick Respond Code (QR Code) as a two-dimensional machine-readable barcode system is developed by the Japanese manufacture company Denso Wave.[177] Initially designed for automotive industry in 1994, this QR Code (Figure 6-Left) can store larger amount of data compared to one-dimensional barcodes. It is basically a square grid matrix on a white background and there are three squares at the corners to track and locate the graphic. After the QR Code is detected, it is analyzed by programmed processor that locates the three squares at the corners. The smaller black pixels converted to binary numbers and validated with error-correcting algorithm.

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[176] Ibid. 367.

[177] Denso Wave Company, website. Accessed in 2018/08/09 from http://www.qrcode.com/en/

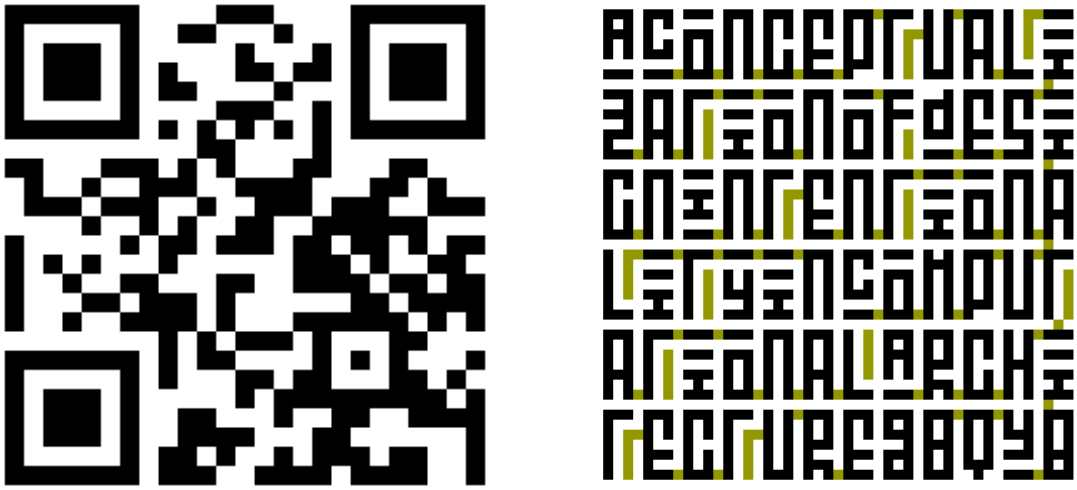

**Figure 6 Left: 'QR Code' generated from www.qr-code-generator.com, Right: 'Human Readable Quick Response Code' generated from http://hrqr.org/**

As a criticism of the unintelligibility of the design of the QR Code by human reasoning, A Human Readable Quick Response Code (HRQR Code) is designed by MIT Media Lab, Fluid Interfaces Group that gives a visual access for better human readability.[178] (Figure 6-Right) In this code, the black pixels are placed in a way that the resulting image has characters from Latin alphabet so that it becomes readable by human beings as well as machines. In this comparison, it can be claimed that the QR Code is counterintuitive to graphic reason which leads to an implicit parallelism in the coupling of the concepts of formalism and computational with intuitionism and graphic.

[178] 'Human Readable Quick Response Code' is developed by MIT Media Lab, Fluid Interfaces Group. http://hrqr.org/

### 3.2. Emergence and emergent properties of computational tools

As discussed in Chapter 2, the research model of the thesis necessitates using two theoretical frameworks with reference to the proposed relationship between the concepts of *intentionality* and *emergence* which are established through a hermeneutical relationship between designers' intentional content and the emergent content provided by the computational design tools. This study identifies the notion of emergence as a facilitator to reinvent design thought. Therefore, this part will focus on the emergent properties and generative capacities of computational design tools which are conceptualized as 'intellectual tools' that mediate the production of new and novel ways of design thought.

In the general sense, the term emergence is defined as the act or process of coming into existence, appearing or becoming known.[179] This definition suggests a process whose visibility is delayed with an apparent disappearance, therefore, emergence can be conceived as the process that resists representation and whose existence is embodied in its properties therefore unknown until it becomes visible. The authors of *Emergent Technologies and Design* Michael Hensel, Achim Menges and Michael Weinstock state that: "Emergence provides an explanation of how natural systems have evolved and maintained themselves, and a set of models and processes for the design and fabrication of architectural forms that exhibit complex behavior, and perhaps even real intelligence."[180] In the scope of computational design, the concept refers to the conditions that exceed determinate anticipation since it exhibits complex behavior based on natural systems, demanding "new strategies for design, strategies

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[179] Cambridge Dictionary online. Accessed in 2018/06/29 from https://dictionary.cambridge.org/dictionary/english/emergence

Oxford Dictionaries online. Accessed in 2018/06/29 from https://en.oxforddictionaries.com/definition/emergence

[180] Michael Hensel, Achim Menges and Michael Weinstock. "Introduction," *Emergent Technologies and Design*: *Towards a Biological Paradigm for Architecture.* NY: Routledge, 2010: 11.

that are derived from the evolutionary development of living systems, from their material properties and metabolisms, and from their adaptive response to changes in their environment."[181]

### *On the nature of explanation*

In "Emergence, Causality and Realism," Manuel De Landa examines "the modern debate on the question of emergence" and its possible contemporary implications in the context of "the nature of explanation" with reference to earlier and contemporary emergentists.[182] To describe the concept of emergence and how it is different than any causal production, De Landa refers to George Henry Lewes –the philosopher who introduced the term 'emergent' in 1875.[183] According to Lewes, "something is an emergent only to the extent that we cannot deduce it from a law, and it ceases to be so the moment a law becomes available,"[184] i.e., if we can explain the rules, the emergent qualities cease to exist. De Landa argues against this account of emergence, as he claims it is "a serious misunderstanding of the nature of explanation in general and of causal explanation in particular."[185] He further claims that this "unfortunate conclusion" is a result of "the line of thought that helped discredit the notion of emergence for several generations" due to the position that rejects mysticism and "natural piety" assuming that anything that is unexplainable directly refers to a mystic phenomenon.[186] On the other hand, according to De Landa, a contemporary philosopher Mario Bunge, who has rehabilitated the concept of emergence by eroding its connotations of linearity and homogeneity, asserts that the "possibility of analysis

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[181] Ibid.

[182] De Landa. "Emergence, Causality and Realism", 381-392.

[183] Ibid. 382.

[184] Ibid.

[185] Ibid.

[186] Ibid.

does not entail reduction, and explanation of the mechanisms of emergence does not explain emergence away."[187]

With the departure from the linear causality of the term emergence, different forms of nonlinear patterns of causality can be derived. According to De Landa, in complex series of events "not only an entity's capacity to affect but also its capacity to be affected" must be taken into account, while "the latter is not just the passive side of the active capacity to affect but equally active on its own, although depending on activity at another level of organization, that of the component parts."[188]

***Emergent properties and 'singularities'***

> [E]mergent properties give reality a means to enter into an open-ended becoming, with new wholes coming into existence as tendencies and capacities proliferate.[189]

On the ontological status of emergence, i.e., on the study of the structure of emergence, De Landa informs that entities have 'actual properties' and also 'causal capacities'.[190] He gives a detailed definition on the mechanism of emergence in which the property of a whole is assessed with reference to the affective capacities of its constituent parts in which causal interactions occur, i.e., the mechanism of emergence behind the properties of the whole happens when parts exercise their affective capacities that enable them to affect and to be affected.[191] Accordingly, in emergent wholes, the component parts may be assigned with different activities and interactions:

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[187] Mario Bunge. *Causality and Modern Science*. New York: Dover, 1979: 156. *Cited in* De Landa. "Emergence, Causality and Realism", 383.

[188] De Landa. "Emergence, Causality and Realism", 384.

[189] Ibid. 392.

[190] Ibid. 385.

[191] Ibid.

> Some component parts, for example, may be part of feedback loops in which one part that is affected by another may in turn react back and affect the first; other components may remain unaffected until the level of activity around them reaches a critical threshold at which point they may spring into action; yet other components may be produced or destroyed during an interaction.[192]

Pointing out the complexity achieved by the "interacting parts operating at different scales and exhibiting different degrees of organization," De Landa claims that the emergent effect is achieved through the mechanism of diversity of actions and relations, and the heterogeneity among agents –some of whose affect may be relatively large due to "their internal repertoire of behaviours" and some may contribute to "the emergence of the whole through effects that are statistical."[193]

Besides defining such concrete mechanism in an emergent effect, it is also important to reveal the Deleuzian "singularities"[194] that structure the possibility space in order to "distinguish linear from nonlinear causality," and so to "counteract the idea that explanation is deduction from a general law, and that emergence implies the absence of such a law."[195] De Landa notes two types of approach to the notion of singularities; one being a single point singularity that structures the state space of linear causality in which a single point is "sufficient to deduce what the final state of a process will be", and the second being the conception of multiple singularities of different types in

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[192] Ibid.

[193] Ibid. 385.

[194] In Stanford Encyclopedia of Philosophy, Deleuzian account of singularities are defined as "remarkable points at which the pattern can shift" and that "mark the thresholds at which systems change behavior patterns." In: Smith, Daniel and Protevi, John, "Gilles Deleuze", *The Stanford Encyclopedia of Philosophy* (Spring 2018 Edition), Edward N. Zalta (ed.), accessed in 11/06/2018 from https://plato.stanford.edu/archives/spr2018/entries/deleuze/

"A Deleuzian singularity is an event, but the notion comprises the effectuation of the event into form." In: Peter Borum. "The Notion of 'Singularity' in the Work of Gilles Deleuze" in *Deleuze Studies*, Jan 2017, vol. 11, No. 1: 95-120.

[195] De Landa. "Emergence, Causality and Realism", 385.

which "each singularity brings about its own sphere of influence," whose knowledge is not directly accessible.[196] From this discussion, it can be concluded that the moments of interference in emergent processes can be conceptualized as singularities if those moments have influence on the course of action.

Based on De Landa's discussions on the emergent capacities and singularities, it can be concluded that emergence is a potential in which an increased capacity of computational tools allows designers to interact with an expanded, complex possibility space. De Landa claims that the "increased repertoire of formal resources" can be used to investigate possibility spaces and "should therefore contribute towards a trend for a greater appreciation of virtual structure."[197] Although he doesn't use the exact terms, De Landa's account of emergence and his idea on the capacities of entities 'to affect and be affected with' can be read with the concepts of agency and action in which "the human component of the assemblage is a community of practitioners."[198]

### 3.3. Algorithm as generative agency

For a general definition, an algorithm is a well-defined computational procedure comprising a series of steps that are followed in order to solve a problem.[199] In the formation of design processes, algorithms can be applied in codes that allow for feedback, recursive decision processes, optimization of organization, search and selection, evolution etc. For instance, genetic algorithms provide mathematical models mimicking relations, phenomena and behaviors found in nature, such as evolution, mutation, fitness and reproduction. Within the last two decades, algorithms have found excessive use and occupied a major place in architectural design research. In search

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[196] Ibid. 389.

[197] De Landa. *Assemblage Theory,* 185.

[198] Ibid. 88.

[199] "Algorithm," Marriam-Webster Dictionary. Accessed in 2018-06-29 from https://www.merriam-webster.com/dictionary/algorithm

for novel architectural forms and geometries, especially generative algorithms such as cellular automata, swarm behavior and agent-based computing are utilized in the field of design.

In her book *Contagious Architecture*, Luciana Parisi problematizes the dominant use of algorithms and claims that algorithms should not be seen as procedures to compute everything with; since, when explored deeply, algorithmic procedures manifest an "incompleteness in *axiomatic*" that occupies the core of computational world.[200] According to Parisi:

> [A]lgorithms are no longer or are not simply instructions to be performed, but have become performing entities: actualities that select, evaluate, transform, and produce data. In this world, algorithms construct the digital spatio-temporalities that program architectural forms and urban infrastructures and are thereby modes of living.[201]

Regarding algorithms as performative entities which have emergent properties, the following questions arise: How do the emergent and performative properties of algorithms alter the conception of intentionality in architectural design research and what are the roles of human and nonhuman agencies in the organization and control of the design process? For example, if the role of algorithmic agency is automation, then how does it affect the whole? If it doesn't have any affect, then its role is redundant. But if it creates a Deleuzian account of singularity, then its agency is meaningful.

Pia Ednie-Brown and Alisa Andrasek, in their article "CONTINUUM A Self-Engineering Creature-Culture" inform about the necessity of repetition in computational design process to achieve intelligence in computational tools that only accumulates through practicing, in order to cultivate "a sense of what works

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[200] Luciana Parisi. *Contagious Architecture: Computation, Aesthetics, and Space*. MIT Press, 2013.

[201] Ibid. ix.

algorithmically."[202] They define algorithmic agency as "a procedure for computing a defined set of relations, usually involving the repetition of an operation," where every particular has its "own behavioral refrain; it assesses the 'ifs' and 'elses', and then acts, over and over."[203]

They state that intelligence is a process in which things are related and connected and the outcome of the process loops back into that "field of connection wherein possibilities and potentials are intensified."[204] Through such practice involving repetitions, designers gain intelligence both to transform the process so that a "kind of rhythmic merger with the variable particularities of an act" occurs, and adaptation between designer and design tool.[205] The recursive relationship between human and algorithmic agency that Ednie-Brown and Andrasek bring into discussion leads to a hybrid form of design intentionality that dwells onto a high level of human experience with nonhuman algorithmic agency. Developing through a recursive and trial-and-error approach in design process, their account of intelligence is "a loopy process that is somewhat like a very deep algorithmic sequencing". [206]

As an example of a hybridization of human intentionality with computational reason and the recursive properties of algorithmic agency, "A Flying Pantograph" can be cited, which is a project developed at the MIT Media Lab in 2015 creating drawings interactively between a human user and an algorithm through a drone.[207] (Figure 7) The motions of the human who holds a pen that virtually draws are transferred on another board through the mediation of the algorithm and the physical act of the drone.

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[202] Pia Ednie-Brown and Alisa Andrasek. "CONTINUUM A Self-Engineering Creature-Culture," in *AD: Collective Intelligence in Design,* Vol 76, Issue 5, September/October 2006: 22.

[203] Ibid. 25.

[204] Ibid. 22.

[205] Ibid.

[206] Ibid. 25.

[207] MIT Media Lab. Accessed in 2018-05-16 from https://www.media.mit.edu/projects/flying-pantograph/overview/

Although the human artist controls the movement of the drawing drone, the drawing algorithm delays the human control and adds some of its own movements based on the emergent properties of the algorithm. By this way, the simultaneous relationship between the artist and the drone is cut and a new collective condition occurs. In the proposed medium, the project incorporates the expressive agency of the drone and the capacity emerging from human-nonhuman interaction by exhibiting the essential and expressive role of the nonhuman in the process of creation.

In this example, the act of drawing is altered through a mediation of programmed agency and the capacity to act is bounded within the structure of algorithm, i.e., its internal repertoire of behaviours. The possibility space is enlarged considering the initial movement provided by the human artist. Yet, this is one or two steps more complex than Jackson Pollock's relationship with his brush and paint who was quite radical in his approach to the act of painting by claiming some active agency for his "intellectual tools" regarding his declaration that "the painting has a life of its own."[208] (Figure 8)

Remembering the first glimpse to the connotations of the concept of emergence –such as the unpredictable, the unthought, and even the unintentional– we observe an opposition to the term intentionality. Recalling Deleuze and Guattari, who "constantly remind us that oppositions can be transformed into one another,"[209] the proposal of this thesis is that the material hermeneutical relationship between intentionality and emergence is becoming noteworthy, where the mark of the distinction between the predictable and unpredictable is no longer discernable.

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[208] Accessed in 2018-05-20 from Jackson Pollock website https://www.jackson-pollock.org/

[209] De Landa. *Assemblage Theory,* 3.

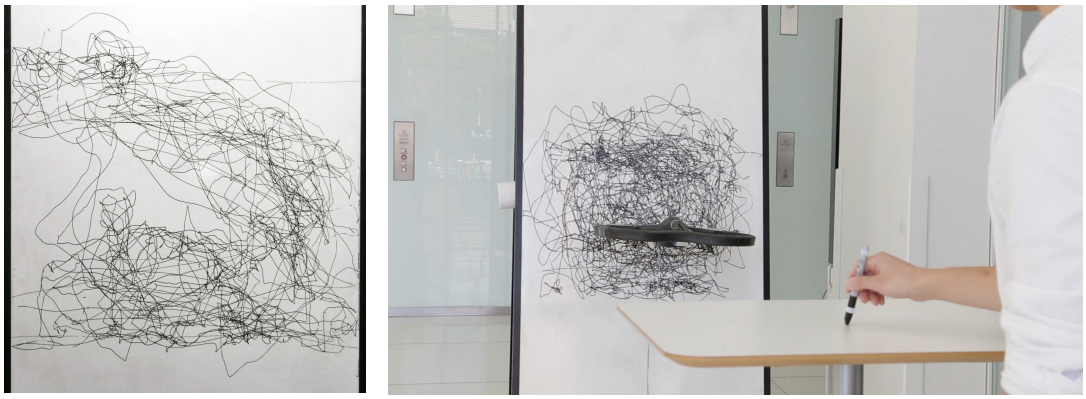

**Figure 7 A Flying Pantograph. Work by Sougwen Chung.** Credit: Sang-won Leigh, Harshit Agrawal. Source: MIT Media Lab. Accessed in 2018-05-16 from https://www.media.mit.edu/projects/flying-pantograph/overview/

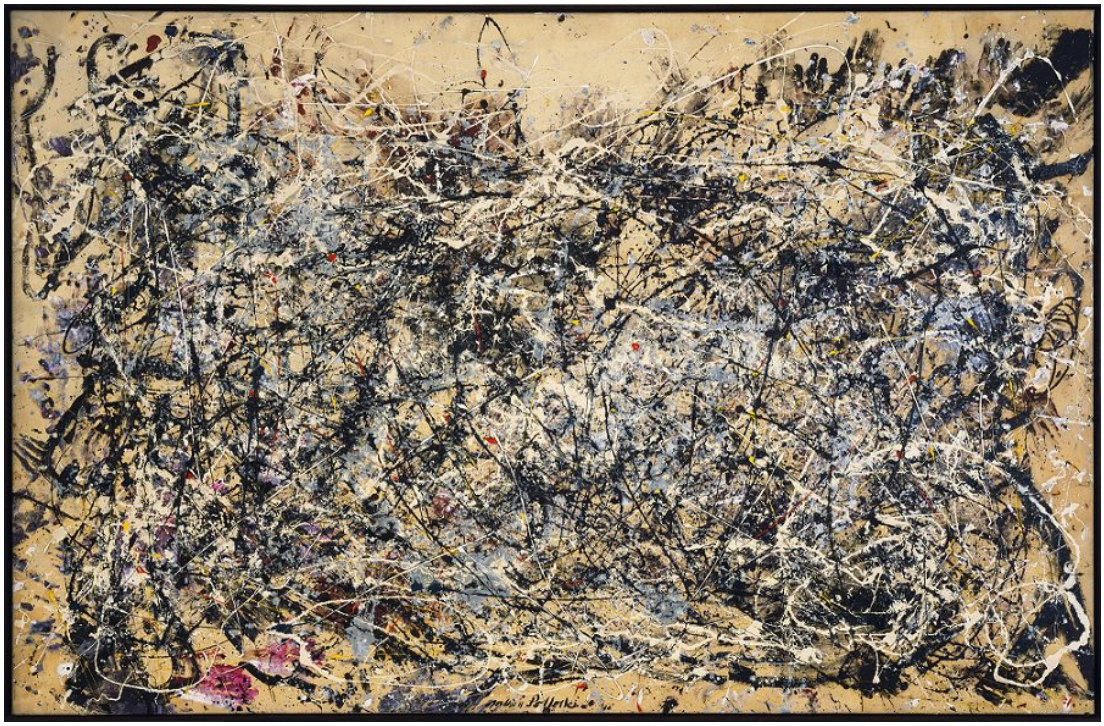

**Figure 8 Jackson Pollock's painting *Number 1* (1948). Brush and paint are the agencies and dripping is the action.** Accessed in 2018-05-20 from https://www.jackson-pollock.org/

The question of the relation between design intentionality and design tools refers back to the human-nonhuman divide which was previously discussed in Chapter 2. The apparent superiority of human agency in this divide has already been challenged by the mobilization of the concept of agency in the domain of computational design that implicitly questions the anthropocentric account of intentional agency in favor of a techno-centric algorithmic agency. The conception of assemblage and an agentic account of intentionality that is sustained by the emergent behavior of algorithmic agency have become central to a conceptualization of design intentionality, in which design process is characterized by a dynamic relationship between human and nonhuman agencies that is continuously modified by a correlative learning process.

As the material hermeneutical account helps clarify, designers' intentionality cannot be abstracted from the technological context in addition to social/cultural ones, and thus, intentional content is never pure and genuine, on the contrary, it is constantly contaminated and synthetically constructed by the interaction and recursive procedures between designers and algorithmic agencies in design process. Through emergence, computational tools have secured the acceleration of this transformation and extended designers' intentional content in an exponential and extraordinary mode. This condition informs a new form of design intentionality which the following chapter will instantiate based on the conceptualization of this thesis establishing a material hermeneutical relationship between intentionality and emergence.

# CHAPTER 4

## DISTRIBUTED MODELS OF INTENTIONALITY IN COMPUTATIONAL ARCHITECTURE

The previous chapter showed that whether computational agency is an extension/prosthesis to design thinking or a reinvention of design thought, it indeed enabled designers with an expanded reservoir of architectural ideas, representations and objects through acknowledging the underlying structure of algorithms and their emergent properties. This chapter presents the research and practice in which emergent properties of computational tools that provide automated, calculated environments are interfered with human modalities[210] with feedback mechanisms that allow for improvisation, speculation etc. Therefore, the current chapter is interested in the productive moment of encounters in which designers and algorithms are accumulated into a single augmented body of agencies that possess different degrees and intensities of intentionality.

This study claims that the nonhuman mediation provided by computational tools and algorithmic agency supports human intentionality by changing perception or aiding to explore the forces or sources that are not directly intelligible or resist visualization i.e. unintelligible to graphic reason in Bachimont's words. The first part of this chapter focuses on these properties, qualities and procedures –such as bottom-up, emergent, automated– that are intrinsic to algorithms and induced by numeric inscriptions mediated by computational agency; and the second part concentrates on the human modalities of intervention into these automated procedures of computation with top-

[210] Modality is a means, a particular way of doing or experiencing something. In human-nonhuman interaction, modalities are "interpretive schemes" like a path of communication between the human and the computer. In: Ian Craib. *Anthony Giddens*. London: Routledge, 1992: 32.

down actions based on design intent such as speculation, improvisation, and interpretation. The specific focus will be on a few designers who work extensively with algorithmic procedures, write specific and custom codes for their design and actualization, thereby, claiming to exhibit distributed and impure models in which design intentionality is generated, exchanged and hybridized in the process of continuous feedbacks both from human and nonhuman agency so that a possibility space for non-systemic, intuitive decisions in computational procedures can develop.

### 4.1. Computational modalities of creativity

Rather than the recognized forms of computing, this part will focus on the creative use of the code in order to show the potentiality of algorithmic agency to expand the possibility space and reservoir of ideas. In its basic definition, a code is a series of instructions that is acknowledgeable to the language of the computer.[211] Algorithm as a mathematical abstract entity necessitates to be coded into a 'programming language,'[212] so that it becomes readable, transformable, executable and performable by a computing environment. Recalling the discussions on the affective power of the nonhuman and the Deleuzian concept of expressive agency which were discussed in chapter 2, this part will exemplify on the expressive and affective power of the code, i.e., how a possibility space can be created by a simple instruction.

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[211] Code, which can be short for source code, is a term used to describe text that is written using the protocol of a particular language. Accessed in 2018/07/25 from https://www.computerhope.com/jargon/c/code.htm

[212] Such programming languages are including but not limited to Python, JavaScript, C++.

***On creative computing practices: Live coding***

An interesting case from the early 1980s is documented in a ten-author book: *10 PRINT CHR$(205.5+RND(1)); : GOTO 10.*[213] The title of the book is a single-line code, which is a BASIC program designed to produce a pattern by repeating the code infinitely until it is interrupted.[214] The power of the book comes from the fact that by operating from a single line of text to discover "seemingly disparate aspects of culture," it takes the opposite approach of the dominant account of research on the effects of computation through reading enormous amounts of data (ubiquitous computing).[215] The claim of the book is that despite its so-called naturalized objectivity (induced by 'computational reason'), a code becomes a peculiar kind of text which has significant social, political, and aesthetic dimensions embedded in the specific ways it is written, maintained and modified by the designer/programmer.[216]

The book also suggests that through a careful examination of the specifics of programs and the code itself, its affective relationship with culture can be traced.[217] This cultural situatedness of the code can claim for its potentiality to have an affective role in a human-nonhuman assemblage with its capacity to affect and be affected. On this expressive power of the code, the authors state:

> Code is not only a conventional semiotic system. At its essence, code also functions. Code runs. Code does something. Code executes on the computer and has operational semantics. But code means things to people as well, both implicitly and explicitly.[218]

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[213] Nick Montford et all. *10 PRINT CHR$(205.5+RND(1)); : GOTO 10*. USA: The MIT Press, 2013.

[214] Ibid.

[215] Ibid. 4.

[216] Ibid. 3.

[217] Ibid.

[218] Montford, et all. *10 PRINT CHR$(205.5+RND(1)); : GOTO 10.*, 263.

One of the main claims of the book is that the code should be valued and acknowledged as an artifact, a resource to understand the human mind and also the human-machine interaction which also gives an access to the invisible world of creative computing.[219] The authors inform about the representational support of computer programs so that "they can depict worldly things and ideas, and they can resonate with related figures, images, and designs."[220]

In order to show how an expanded possibility space occurs through regular repetition and randomness in computing, the book reflects on the specific design of the Commodore 64 and narrates the story of the BASIC programming language, "10 PRINT,"[221] whose output of the program is a visual pattern that resembles a maze - an architectural space, which emerges when the characters appear on the screen from left to right and then top to bottom.[222] (Figure 9) In order to play with the visual possibilities and access to the creative sphere, first, the original code is understood via acknowledging its formal workings, then it is altered, modified and elaborated.[223]

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[219] Ibid. 8.

[220] Ibid. 264.

[221] Ibid. 5.

[222] In the code 10 PRINT CHR$(205.5+RND(1)); : GOTO 10

- The statement PRINT causes its argument to be displayed on the screen.
- CHR$ function takes a numeric code and returns the corresponding character, which may be a digit, a letter, a punctuation mark, a space, or a "character graphic," a nontypographical tile typically displayed alongside others to create an image.
- RND function returns a (more or less) random number, one which is between 0 and 1.
- The GOTO keyword and line number function here to return control to an earlier point, causing the first statement to be executed endlessly, or at least until the program is interrupted, either by a user pressing the STOP key or by shutting off the power.
- RUN is what is needed to actualize the program.

Ibid. 10-16.

223 In the simplest definition, formal workings of a code mean the particular way that a program or code operates. Montford, et all. *10 PRINT CHR$(205.5+RND(1)); : GOTO 10*., 7.

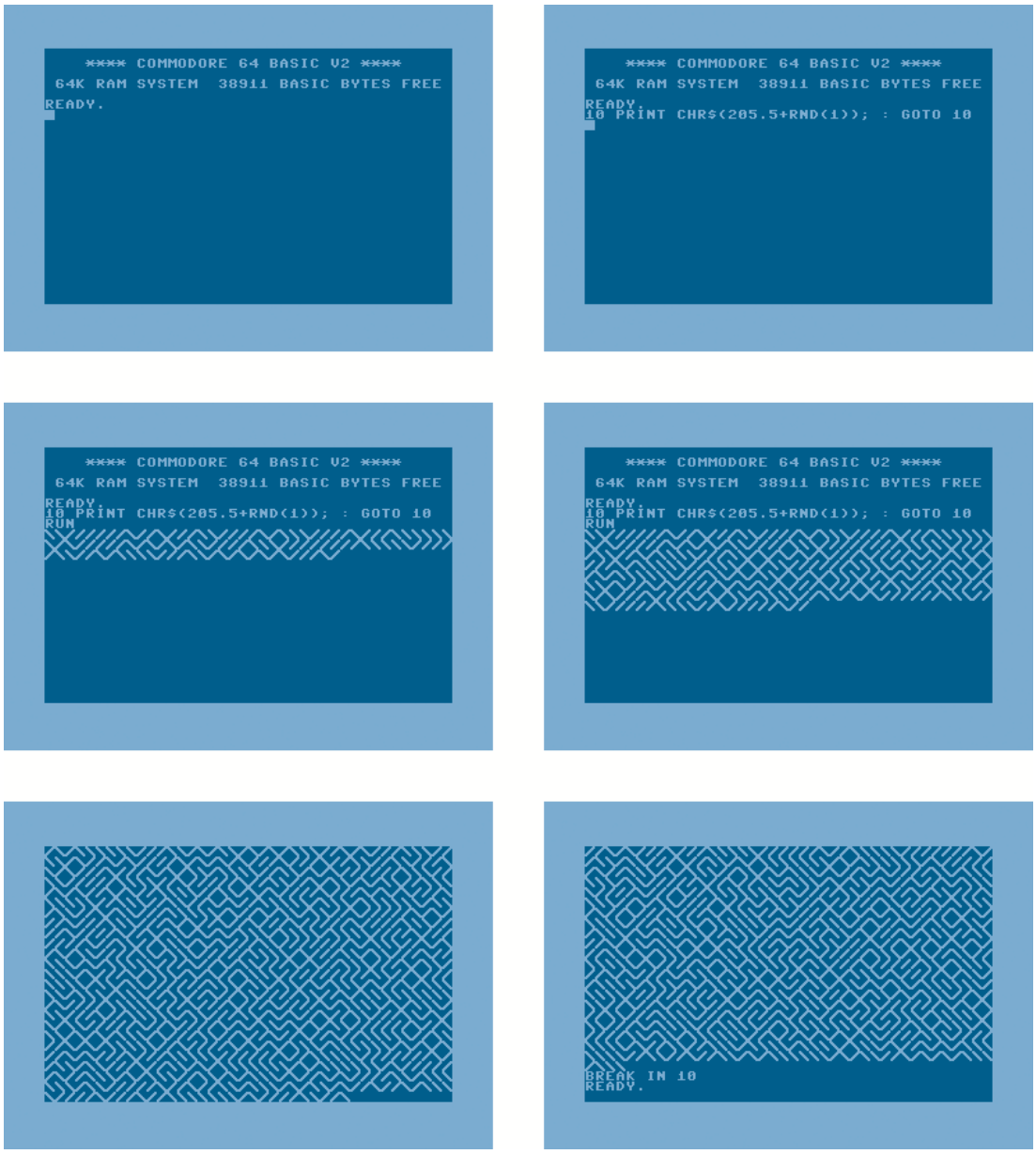
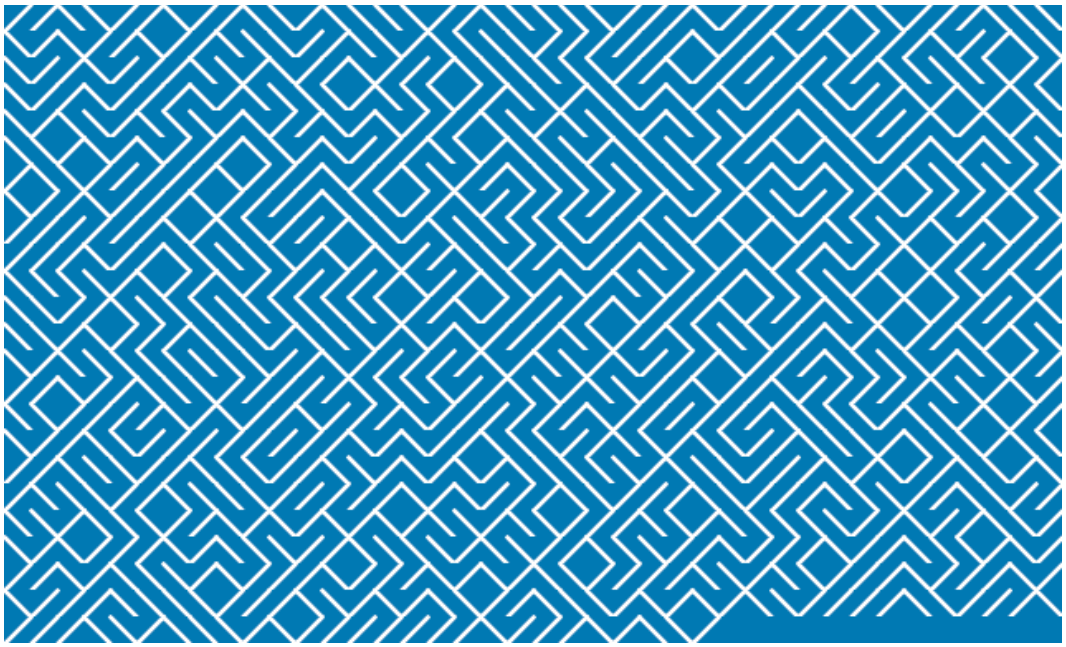
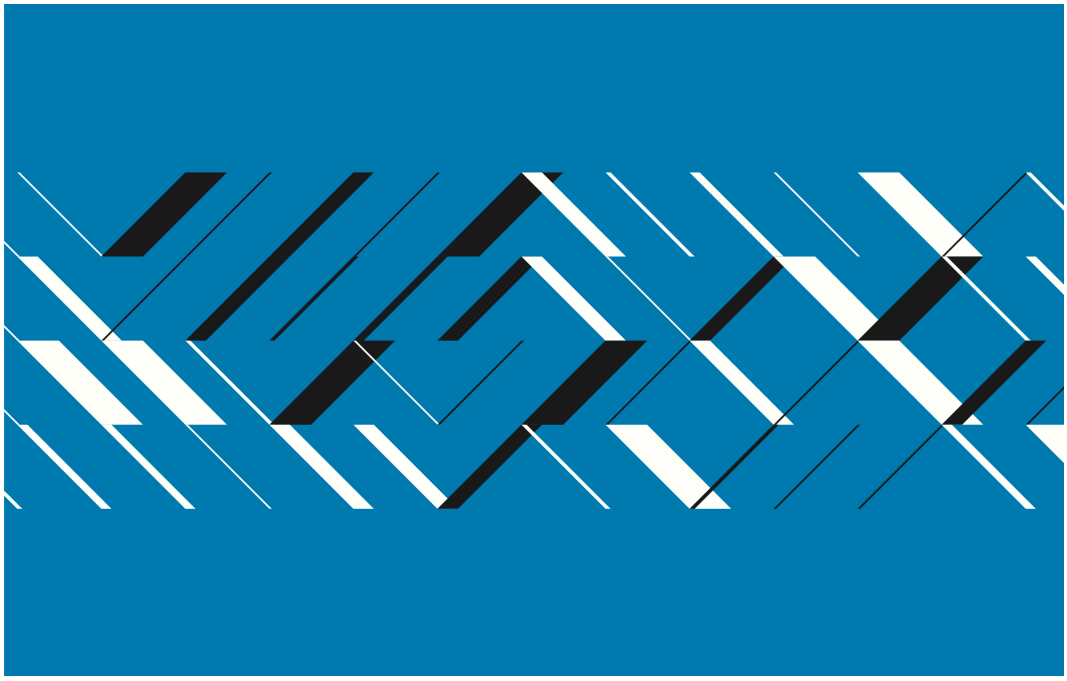



**Figure 9 One-lined code "10 PRINT program" is typed into the Commodore 64 and run: repeat infinitely until it is interrupted.** Source: Nick Montford, Patsy Baudoin et all. *10 PRINT CHR$(205.5+RND(1)); : GOTO 10.* USA: The MIT Press, 2013: 2.



A



B

**Figure 10 (A) Maze pattern in which each line has same color and thickness. (B) Processing program based on 10 PRINT, but significantly different, in which each line has either black or white color and a random thickness.** Source: Nick Montford, Patsy Baudoin et all. *10 PRINT CHR$(205.5+RND(1)); : GOTO 10*. USA: The MIT Press, 2013: 110, 117.

By changing parameters and altering the code, the program generates different patterns as output that leads human agency to think differently. With modifications, such as changing the line weights, colors and the size of the grid or adding different weightings for randomness or again replacing the shape of the component with other shapes, various effects can be explored so that "the program distinguishes itself significantly from its parent and emerges as a qualitatively unique algorithm."[224] (Figure 10)

Through the visual familiarity of the concept of maze, i.e., its culturally and historically established associations, human agency is motivated to attribute meaning to the pattern and synthesize new ideas just by interpreting the outcomes. Drawing attention to the intellectual contribution enabled by the meaning inscribed in the visuality of the program, the authors inform that: "Considering 10 PRINT in light of the cultural history of mazes situates the program's output in a space of symbolic meanings and design principles –the many ways in which something can be seen as mazelike or designed to be mazelike."[225] Therefore, instead of considering the outcomes as new mazes with increased complexity, the idea of maze is especially significant as it emerges out of an absolute simplicity of design:

> If 10 PRINT is a maze in a new and different way, this difference is based in deep similarity to the precursors it resembles, in particular, the way that all mazes arise out of shared principles of regularity on the one hand and randomness on the other.[226]

This example shows how a program's output alters earlier notions of a concept through symbolic meaning or 'graphic reason' and leads to a synthesis of new and novel ideas. The emergent structure of this simple code encourages altering the earlier notions of an architectural program –maze–, every time the human confronts with something new. This exemplifies a desired human-nonhuman encounter, in the line of

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[224] Ibid. 118.

[225] Ibid. 49.

[226] Ibid.

Bachimont's discussion, in which 'computational reason' meets 'graphic reason' provided by the visual representation of the computer screen and evoked by the meanings associated with the metaphor. Such a meeting activates an intersubjective field enabled by 'live coding', an eponymous term that alters the interaction existing between the code and coder through incorporating dynamism and unpredictability of live action so that the outcome is far from fixed as a whole through which an almost simultaneous access to visual representation is provided.[227]

In "Coding Praxis: Reconsidering the Aesthetics of Code," Geoff Cox, Alex Mclean and Adrian Ward suggest considering the act of coding as a continuing performance of its designer, since "code as a notation of an internal structure that the computer is executing, expressing ideas, logic, and decisions" operates as an "extension of the programmer's intentions."[228] They conceive the execution of the code as "a solidification of the creative process" which relies on the "deferred action of its author" so that the code behaves with respect to the programmer's intentions.[229] The macro performance of code occurs with respect to the functioning of many dynamic yet predeterminate micro components: In order to exceed such predetermination that the inner workings of the code entails, the authors propose what they call 'live coding'.[230]

Underlining the inevitability of subjectivity and significance of human agency in such a live process, they claim that the act of coding necessitates "human intervention and full access to the means of production," so that "the human subject gains agency (the

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[227] Geoff Cox, Alex Mclean and Adrian Ward. "Coding Praxis: Reconsidering the Aesthetics of Code," in Alexei Shulgin and Olga Goriunova (eds) *Read_Me: Software Art & Culture*s. Aarhus, DK: Aarhus University Press, 2004: 164.

[228] Ibid. 161-174.

[229] Ibid. 164.

[230] Ibid.

power to act), as one who assembles the apparatus as much as is assembled by it."[231] The predictable qualities of the design of a code is scripted by the programmer, whose "improvisation relies on a predictive understanding of complex and generative systems," who then is able to predict and speculate on the behavior of the code for a certain degree, but this authoring is still uncertain and open for unpredictable results, since "many of the details are not yet known."[232] However, this unpredictability of the behavior of the code is desired for the activation of creativity, as it opens a positive space for the "vagaries of feedback" and the possibility for mistakes.[233]

These approaches in coding practices reveal that through intervening to automated procedures of computation with top-down actions such as speculation, improvisation, interpretation etc., even a simple code can offer a large framework of possibilities whose end results are not yet known.[234] The examples also illustrate that the medium and interface of visualization can also structure the work i.e., the generative capacity is intrinsic to the mediation of intellectual support. In order to activate a performative account, the system and logic of computation should be acknowledged so that the human can claim for an active role, i.e., an agency.

### 4.2. Human modalities of intervention

Dominant accounts of computational design regarded subjectivity and its so-called "mysterious" intuitive modes and reasonings redundant as they were difficult to reconcile with the new understanding of the structuring capacities of technological tools, i.e., the exercise of computational thought. As explained previously in chapter

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[231] Ibid. 169.

[232] Ibid. 169-170.

[233] Ibid. 170.

[234] Ibid.

3, these modes and reasonings are not directly intelligible to computational reason and the formalism it implies. Recalling the gap in-between computational logic and human intuition in computational design research in Zeynep Mennan's reading of Bachimont's account of computational tools, where she stresses the indispensable role of interpretation by stating that "all knowledge proceeds from a material support of inscription of which it is the interpretation,"[235] this part aims to exemplify and discuss the attempts that intervene in algorithmic processes to reclaim subjectivity and intuition which are intrinsically resistant to calculation and quantification.

Announcing a new epistemic, methodological and representational regime in computational design research, Mennan points out the significance of Bachimont's discussion in his introduction of a new standpoint through which the nature of the support that carries information is seen to bring about a computational rationality encouraged by a numerical mediation.[236] Problematizing the infertility of the account that considers computational tools as a methodological choice on the grounds of efficiency, she notifies:

> This means that the current preference in the computational paradigm for privileging formalist procedures and approaches in design and research would extend beyond being a matter of mere methodological choice on the grounds of efficiency, if it is agreed that the nature of the support is fundamentally affecting the ways we understand, conceptualize and interpret data.[237]

With reference to the discussions in chapter 3 and Bachimont's theory of the support, it can be inferred that the emergent properties that algorithmic computation brought with create an expansion of the possibility space both by opening up otherwise inaccessible territories for exploration and, at the same time, by delimiting it. Through the operations of intervening into the automated processes of algorithms, the

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[235] Mennan. "Mind the Gap", 34.

[236] Ibid. 36.

[237] Ibid.

designer's subjective sensibility and intentionality can be restated and human-nonhuman symmetry in design intentionality could be conceived in an unsymmetrical way.

### 4.3. Co-operative spaces of synthesis: Contingencies

On the human-technology interface, mastering and experience with the technological tools enable designers to explore the space in-between the determinate and indeterminate, predictable and unpredictable, rational and irrational qualities and properties so to challenge both poles in order to reconcile design intent and subjective faculties with computational reason. The space generated in-between is open to be filled with new and novel ideas. Intervention, interpretation and 'design hacking'[238] can be counted as human modalities to penetrate into the structure and inner workings of codes and algorithmic computation in order to alter, modify and utilize these intellectual tools, at the same time, to inscribe, encode and embed design intent and intuition.

#### *Between order and chaos: Messy computation and strange feedback*

As discussing the interface between design intentionality and emergent properties of algorithms in which a deep human and nonhuman interaction –e.g. in the act of interpretation and encoding design intent– is necessitated, reference needs to be made

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[238] Andrew Witt informs that hacking emerged in the 1970s as a rebel act in "the subversion of corporate technological systems toward more experimental aims." However, in the field of architecture and design, it is an experimental and exploratory action to intervene into the sequential order of algorithmic operations in order to challenge the determinism that computational reason brings forth. The project of design hacking consists of manipulating the technological world, finding ways to transform the computing machines themselves, repurposing technology so to open "methodological avenues for visual and material experimentation." As Witt notifies, through hacking "design gains a new range of activity and freedom," therefore design hacking can be conceived as an intellectual support for "synthetic possibilities" both for design and the knowledge culture of architecture." See: Andrew Witt. "Design Hacking: The Machinery of Visual Combinatorics," Log, No. 23, Fall 2011: 17-25.

to Roland Snooks who both researches and practices on this exact interface.[239] Zeynep Mennan refers to the work of Roland Snooks Studio and *Kokkugia*[240] in which the designers attempt to bridge computational formalism and design intuition by "embedding architectural design intention within generative algorithms."[241]

Interested in the exploration of the algorithms whose underlying logic is defined through natural phenomena (such as self-organization, swarm behavior etc.), Roland Snooks claims that what offers significant generative potential for architecture are the emergent capacities of complex systems that are going back and forward between order and chaos.[242] Through altering the predictable order, complex systems are effective with generative properties and their capacity for catastrophic change by maneuvering on the borderline between order and chaos.[243] Despite the very

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[239] Roland Snook's PhD thesis focuses on the emergent processes of formation and architectural design intention. Snooks considers design intention as behaviors that locally interact in a self-organizing process of formation. Roland Snooks. "Behavioral Formation: Multi-Agent Algorithmic Design Strategies." Unpublished Ph.D. diss., RMIT University, 2014. Retrieved from RMIT University Research Repository, https://researchbank.rmit.edu.au/eserv/rmit:162237/Snooks.pdf in 2018/07/25.

[240] Established in 2004 as a collaboration between architects Roland Snooks and Robert Stuart-Smith, Kokkugia is an experimental architectural research collaborative that operates as Studio Roland Snooks' research and development platform. While Studio Roland Snooks provides architectural services with a focus on realizing innovative architecture, Kokkugia's role is more speculative - to imagine the future" by exploring "generative design methodologies developed from the complex self-organizing behavior of biological, social and material systems." The design agenda of Kokkugia's is "to develop a non-linear architecture, one that emerges from the operation of complex systems and questions the established hierarchies that operate within architecture. This methodological inquiry is focused on developing a behavioral design process, one in which design intent operates through local behaviors rather than through the explicit description or parametric manipulation of form and organization. This approach involves encoding simple architectural decisions within a distributed system of autonomous computational entities, or agents. It is the interaction of these agents and their local decisions that self-organizes design intent, giving rise to a form of collective intelligence and emergent behavior at the global scale. This enables a reconceptualization of matter within the design process, a shift from form being imposed upon inert matter, to matter playing an active role in the emergence of form and organization." Accessed in 2018-06-24 from http://www.kokkugia.com/

[241] Mennan. "Mind the Gap", 40.

[242] Roland Snooks. "Volatile Formation," *Log 25*. Anyone Corporation, summer 2012: 56.

[243] Ibid. 55.

difficulties, Snooks encourages designers to engage with the speculative potential of computational procedures instead of privileging certainty over open-ended processes, and argues for complex systems of formation that operate through the volatile interaction of algorithmic behaviours (such as, generative, self-organized and emergent behaviors).[244] Generating complexity within computational design through exploring the unknown set of architectural hierarchies and definitions, he promotes employing generative algorithms with major roles in architectural design. [245] On this volatile strategy which brings the logic of swarm intelligence into design space operating through the self-organization of multi-agent systems, Snooks states that:

> These methodologies operate by encoding simple, local architectural decisions within a distributed system of autonomous computational agents. It is the interaction of these local decisions that self-organizes design intention, giving rise to a form of collective intelligence and emergent behavior at the global scale. Such behavioral formation represents a shift from "form being imposed upon matter" to "form emerging from the interaction of localized entities within a complex system."[246]

Snooks' proposal, what he calls as 'behavioral formation', is a nonlinear algorithmic design methodology in which he declares to inscribe the exact architectural intent within the local interfaces of multi-agent systems.[247] Within such formation, he aims to disallow the equilibrium that algorithmic procedures entail by negotiating with the resistance of algorithmic mechanisms (such as swarm behavior's resistance to work on surface) through employing two modes of operation: the first mode is what he names as 'messy computation,' which is an uncertain feedback mechanism negotiating

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[244] Ibid. 56.

[245] Ibid. 58.

[246] Roland Snooks / Kokkugia. "Self-Organized Bodies," in *Architecture in Formation: On the Nature of Information in Digital Architecture*, Pablo Lorenzo-Eiroa and Aaron Sprecher (eds.) NY: Routledge, 2013: 265.

[247] Snooks. "Volatile Formation", 55.

between the micro scale –the local rules of algorithmic systems– and the macro scale –designer's explicit architectural design decisions–;[248] and the second strategy is that of the 'strange feedback' which provides space for intuitive decisions in computational procedures, i.e., ascribing such feedback mechanism with a non-systemic intuitional/heuristic role.[249] This means that by delegating some micro level design decisions to algorithmic agency, Snooks both actualizes his top-down design intent and achieves the complexity and indeterminacy that algorithmic tools facilitate. Regarding the agentic account of design intentionality that this thesis proposes, the resultant condition can be claimed to be a new form of design intentionality: an intersubjective field, a hybrid constellation, in which a negotiation occurs between both human and nonhuman design agencies who implicitly or reflectively share a common goal or responsibility.

Snooks notes that generative algorithms are basically "templates" or "abstract formal generators" that are "oblivious" to design intentionality, which means that a subjective design sensibility is not operable by the algorithms at the micro level of agency; therefore, their applicability is conditional to the skills of designer to translate architectural intent within the operation of algorithm.[250] In 'messy computation', the designer literally and explicitly interferes in the flow of algorithmic procedures that are capable of generating highly emergent outcomes, in order to draw the resultant configuration towards design intention through employment of recursive feedback loops until an intelligible behavior and set of organizational and formal characteristics occur.[251] For Snooks, what happens at the borderline between the computational logic

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[248] Ibid.

[249] Snooks informs that in strange feedback, "the output of the algorithmic process becomes the input to a direct modelling process where it is edited manipulated and returned to the volatile space of algorithmic formation." Snooks. "Behavioral Formation", 101.

[250] Snooks. "Volatile Formation", 58.

[251] Ibid. 61.

of algorithmic procedures and the designer's intuitive modelling –as a reflection of subjective evaluation and direct design decisions– is a synthesis, a hybridization of the potential of each mode of design.[252] He notes:

> Algorithms need to be manipulated until they break then re-designed and broken again in a continuous loop. They are not essentialist or pure but simply one of the many tools of the architect.[253]

The resultant configuration of such negotiation between the designer's intuitive feedbacks and the generative capacity of algorithms can still be claimed to be emergent, but iteratively, it is refined to respond to design intentions so that it becomes 'impure', 'strange' and unique.[254] Here, the interpretive capacity of the designer is indispensable in communicating through a synthetic vocabulary that is unique to the specific architectural problem and algorithmic mediation towards a resolution. With a "fundamental concern for the importance of subjectivity and the nature of risk within design," Snooks argues for volatility in design research, which he claims is more than a theoretical concern, since it has a potent in extending the architectural possibility space by providing new synthetic forms of order, generating strange behaviors and encoding design intention on the character rather than on the form of algorithm. [255]

In order to investigate the "strange specificity of objects that emerges from behavioral processes of formation," the work of Studio Roland Snooks produces projects that are defined by "complex fibrous assemblages" and proposing "weird and wonderful atmospheric affects" whose "characteristics are intrinsically tied to the nature and behavior of the computational and material processes through which they are designed

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[252] Ibid. 61-62.

[253] Snooks. "Behavioral Formation", 103.

[254] Ibid.

[255] Snooks. "Volatile Formation", 62.

and fabricated."[256] Roland Snooks informs that the intensity, resolution and complex order of such affects resist explicit visualization as these are "emergent properties of the volatile self-organizing interaction of populations of fibrous bodies."[257] He notes:

> Form, gesture and silhouette are external to the ontology of the algorithms that generate these intricate masses, while sensitivity to initial conditions within the algorithmic process resists design intention at this macro scale. Instead, the nature of the topology, the thickness of the swirling mass and its compression to manifold surfaces are emergent outcomes of iteratively refined design intentions encoded within the behavior of the algorithms. This represents a shift from designing form to designing the accretion of mass imbued with atmospheric spatial affects from which the strange characteristics of the objects emerge.[258]

In their proposal for National Art Museum of China (2011), Roland Snooks and Robert-Stuart Smith converge two design strategies, turbulent algorithm and explicit modelling of cloud-like forms, into a feedback relationship in which an outcome of one strategy becomes the input for the other, providing that they become an inseparable whole. [259] (Figure 11)

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[256] Roland Snooks. "Affects of Intricate Mass: The Strange Characteristics of the RMIT Mace and NGV Pavilion," *AD*. John Wiley & Sons, 2016: 74.

[257] Ibid. 74.

[258] Ibid. 77.

[259] Snooks. "Behavioral Formation", 117, 119.

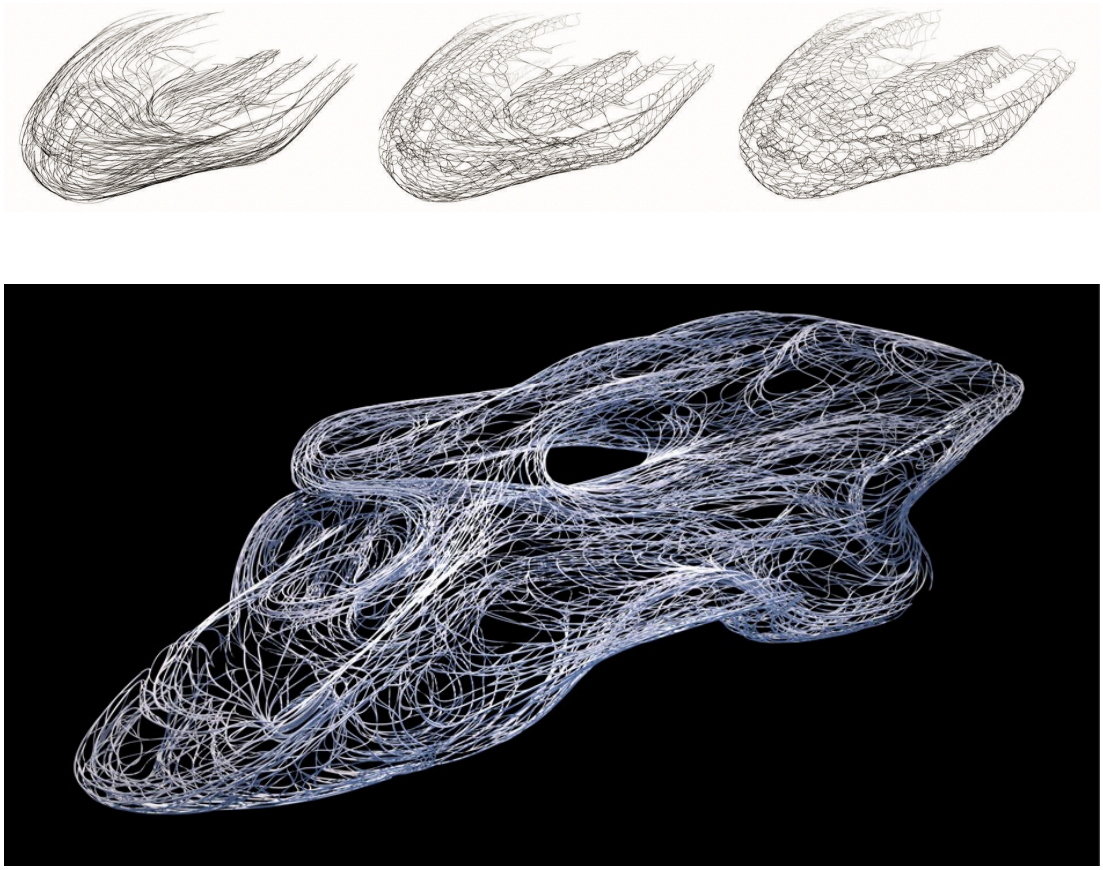

**Figure 11 Proposal for National Art Museum of China, 2011. Design directors Roland Snooks and Robert-Stuart Smith.** Source: Roland Snooks. "Behavioral Formation: Multi-Agent Algorithmic Design Strategies." Unpublished Ph.D. diss., RMIT University, 2014: 119. Retrieved from RMIT University Research Repository, https://researchbank.rmit.edu.au/eserv/rmit:162237/Snooks.pdf in 2018/07/25.

The project which Snooks and his team designed as a national symbol for Kazakhstan for an invited design competition in 2013 continued the same approach.[260] (Figure 12) Both for the National Art Museum of China and the Kazakhstan Symbol, the designers fostered the emergent capacity of turbulent behavior algorithm, whose initial vectors are predefined by the designers, as a form generator in order to negotiate in a strange

[260] Ibid. 125.

feedback.[261] Again, the negotiation is established between an intuitive natural metaphor and the organizational complexity of algorithmic computation by articulating a cloud-like formed direct surface modelling with patterns of turbulent fluids.[262]

These two similar projects are differentiated in their scale and intricacy of ornaments on their surface modellings: The National Art Museum of China is a larger scale project and the intricacy of fibrous components are less apparent, on the other hand, the Kazakhstan Symbol is smaller in scale and more expressive and messier in the articulation of the "hair" elements.[263] Prior to the resulting assembly, Snooks interprets that "the generation of the form, the design of the pattern of hairs, and the flow of air over these are caught in a feedback loop - a negotiation that is less about optimizing performance and more about creating a compelling relationship between form, pattern and wind."[264] Snooks claims that the resulting formal language for both projects -a language composed of "hairy", "fibrous" and "blurred" elements is "a highly personal formal language" which is based on his research and experimental practice arising not only from the direct outcomes of agent-based processes but also from his ability to transcribe his subjective and intuitive design decisions into the emergent algorithmic process through his methods of strange feedback and messy computation.[265]

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[261] Ibid. 125.

[262] Ibid.

[263] Ibid. 127.

[264] Ibid.

[265] Snooks states that his personal formal language has been influenced by the works of Jason Payne and Francois Roche. He also notes that Tom Wiscombe coined the term "messy computation" to refer to a similar process of feedback between intuition and computation. Ibid. 15, 105.

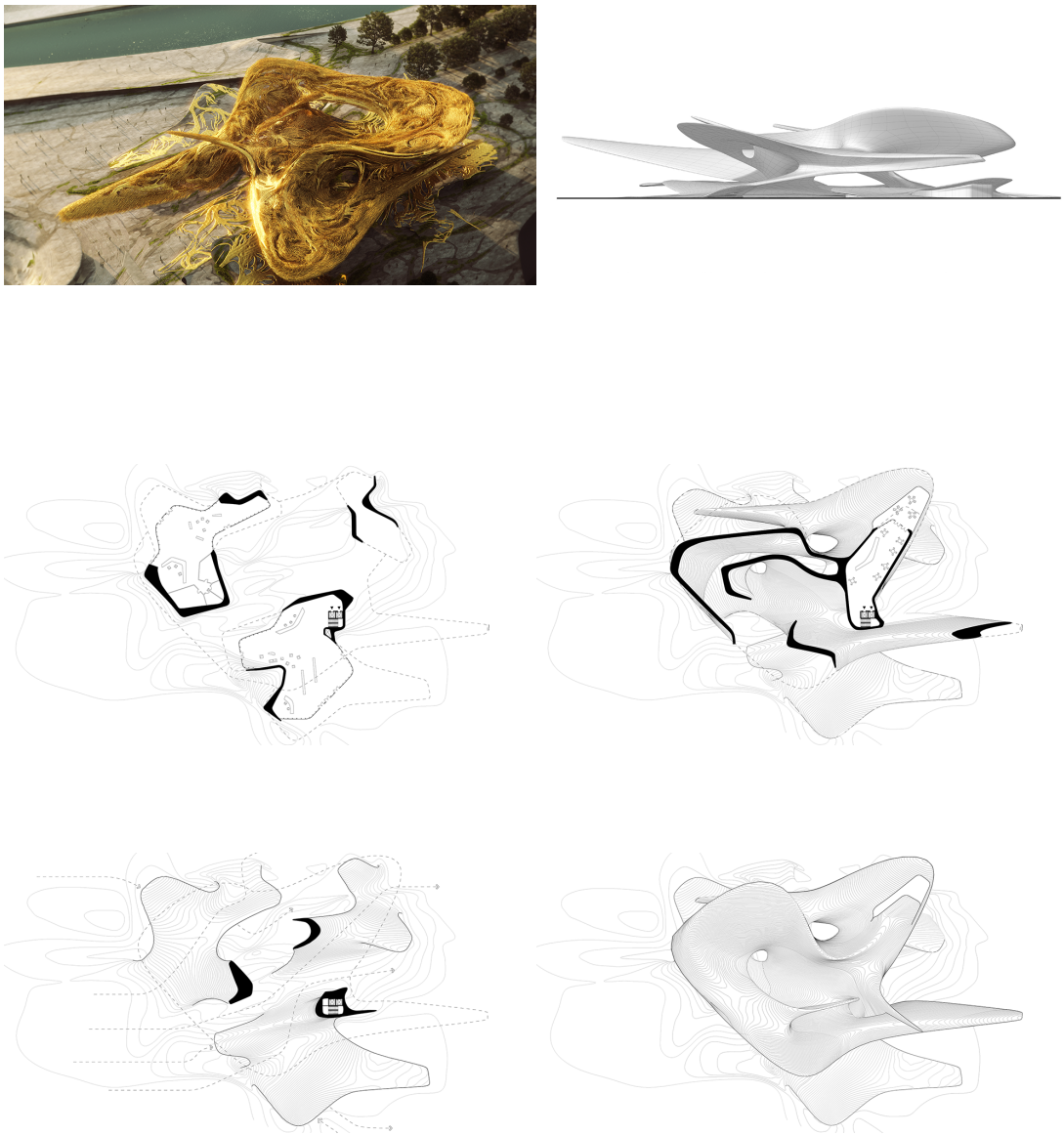

**Figure 12 Kazakhstan Symbol, 2013. Project Team: Roland Snooks (Design Director), Michael Ferreyra, Armin Senoner, Zak Kljakovic, Marc Gibson, James Pazzi.**
Retrieved from http://www.rolandsnooks.com/#/kaz-symbol/ in 2018/07/27

In Alisa Andrasek's approach to algorithmic computation, architecture is a synthetic field in which the complexity of many negotiating agencies is mediated, therefore rendering the notion of contingency inevitable.[266] Two projects by Andrasek, with difference in scale and resolution will be discussed to illustrate and reflect on her approach to algorithmic agency.

The first project, Cloud Osaka, is an outcome of a complex synthesis at the scale of a master plan, in which Andrasek aims to create an "alien approach to the aesthetics of strange and unseen." [267] (Figure 13, Figure 14) As in Roland Snooks' approach, we observe a challenge to go beyond a deterministic account of architectural design through reconciling intuition with algorithmic agency. In this specific case, the source of inspiration is the "river of people" and the algorithmic agency is defined as a custom computational toolset imposed upon a voxel cloud generated with fluid dynamics.[268]

Inspired by cloud formations and weather events, Cloud Pergola is a 3D lattice structure designed to be exhibited at the 2018 Venice Biennale. (Figure 15) An algorithm of multi-agent systems is used in the design of the pavilion, in which these agents are regarded as "active discrete elements whose behavior is determined by a collection of rules, often based on stimulus-response logic."[269] The overall form results from the emergent effects of algorithmic agency whose micro components are designed to behave collectively in order to create complexity.[270]

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[266] Alisa Andrasek. "Open Synthesis toward a Resilient Fabric of Architecture," Log 25, Summer 2012: 46.

[267] See Alisa Andrasek's online portfolio. Accessed in 2018/07/27 from https://www.alisaandrasek.com/projects/cloud-osaka

[268] Ibid.

[269] Ibid.

[270] Ibid.

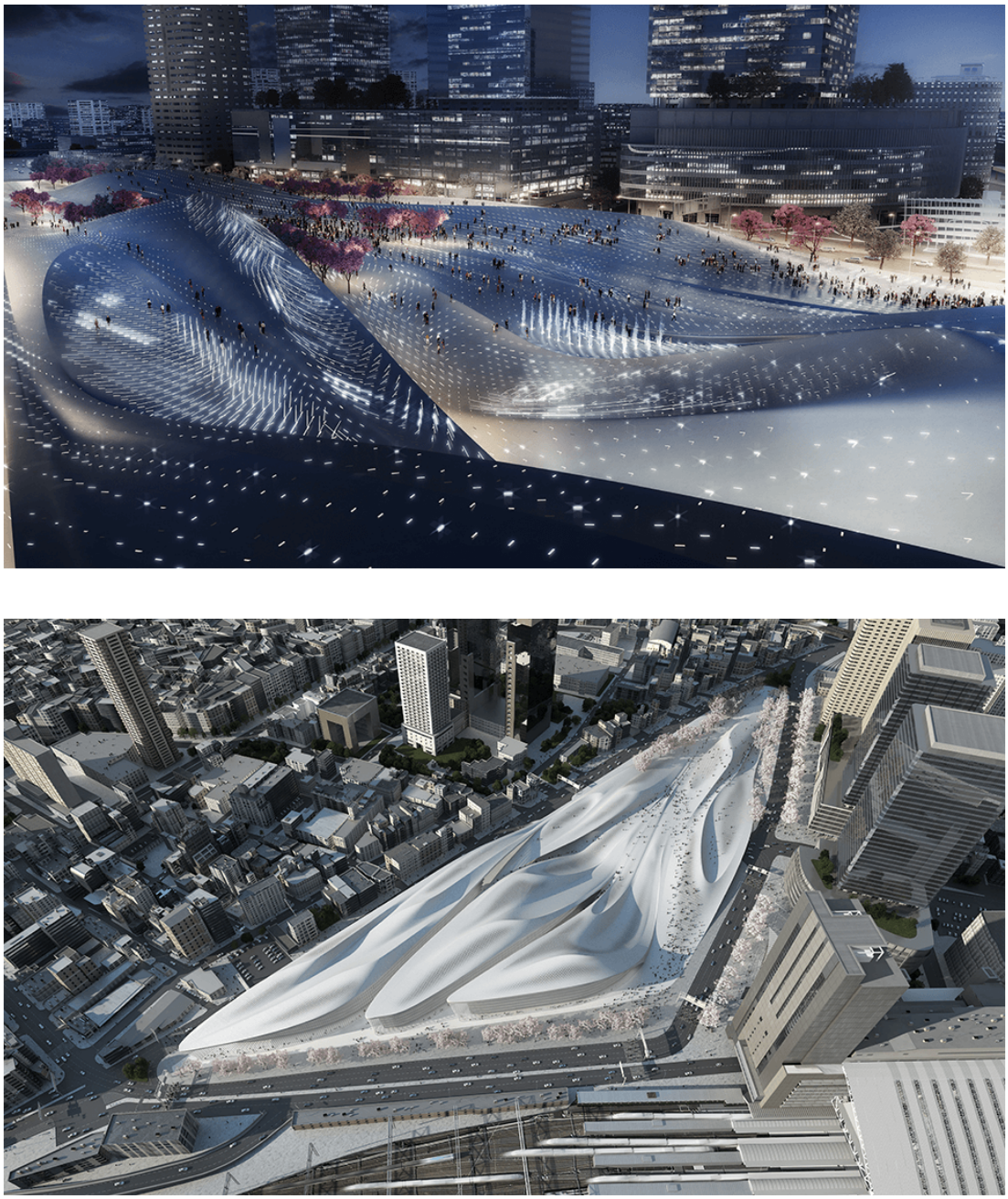

**Figure 13 Complex synthesis at the scale of a master plan, Cloud Osaka by Alisa Andrasek, 2014.** Accessed in 2018/07/25 from https://www.alisaandrasek.com/projects/cloud-osaka

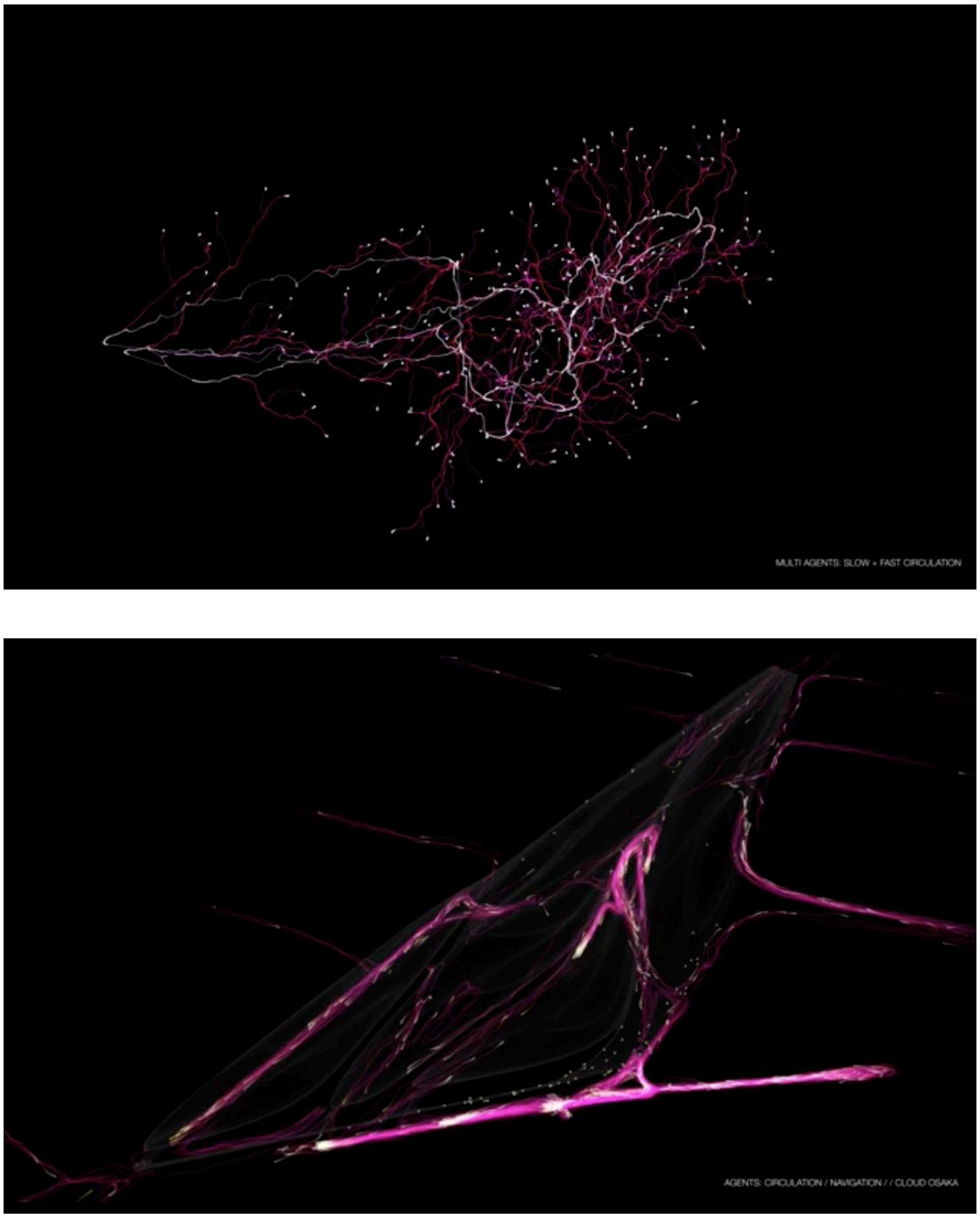


**Figure 14 Screenshots from the video that simulates the multi-agent algorithms used in Cloud Osaka project for circulation and navigation in the site.** Accessed in 2018/07/25 from https://www.alisaandrasek.com/projects/cloud-osaka

**Figure 15 3D lattice diagram of Cloud Pergola, Croatian Pavilion in 2018 Venice Binnale, design led by Alisa Andrasek.** Retrieved from https://www.alisaandrasek.com/projects/cloud-pergola in 2018/07/29

In her work, Andrasek attributes design with a 'catalytic agency' that expands the existing environments and synthesizes new ones.[271] On the agentic account of computational tools, Andrasek notes:

> In mining the resources of computational "otherness," architecture can open up novel spaces of synthesis and go beyond any deterministic design intent on predisposed knowledge derived from its sites. Invisible strata of reality could be unveiled to synthetically alter this fabric. Recognizing the active participation of nonhuman forces in events and understanding that the agency spawns beyond just the human provide a ground for alternative ways of addressing design ecology. In a context where all agencies are intricately interlaced with one another, the possibility of open synthesis reveals a resilient new fabric of architecture.[272]

These design strategies and methodologies show that architecture's capacity to synthesize the complexity of many negotiating agencies becomes possible by the experimental accounts centered in between technology and the human in general and between coding practices and the creative sphere of architects in particular. Both Snooks' and Andrasek's studios reveal innovative approaches in computational architecture by recognizing the contributions of algorithmic agencies and reclaiming the subjective and intuitive design faculties. With an inclusive approach to the mediation of nonhuman forces, an alternative account of design intentionality, which can escape from the deterministic qualities of top-down design intent, becomes therefore possible.

Instead of exploitation and direct application of computational procedures in order to ground the already determined set of architectural ideas or forms through the pseudo-objectivity of computational reason, such exploratory approaches to algorithmic agency promote more of experimentation with the conflict that emerges in the interaction between intuitive top-down architectural intent and emergent bottom-up

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[271] Andrasek. "Open Synthesis toward a Resilient Fabric of Architecture", 46.

[272] Ibid. 54.

operations so that creative moments of encounters occur and lead to new and novel ways of thinking.

Rather than adopting multi-agent systems simply to generate pattern and form, the design methods proposed by architects who look for innovation at the interface of design and technology, drop the charge of indeterminacy carried by the emergent properties of computational tools. Based on a continuous testing of human and nonhuman, these contingencies in the co-operative spaces of synthesis render the interface between the designer and the code intelligible and become an assemblage, a field of extension into the agentic capabilities of both.

# CHAPTER 5

# CONCLUSION

The contribution of this study to the theory and discourse of architecture consists of the development of a conceptual framework which has a twofold action both in the mobilization of taken-for-granted notions used in architectural design and the introduction of a fresh approach to the conceptualization of design tools. The hermeneutical framework that the thesis has exercised in (re)conceptualizing design intentionality has led to a deeper examination of the complexity of the design process and the multiplicity of actors involved by scrutinizing a holistic understanding of the human-technology relationship between designers and intellectual tools and their operational extensions in computational architecture: computational design tools in general and emergent properties of those tools in specific.

It has been pinpointed that the conventional definition of intentionality as grounded in human consciousness has weakened with the introduction of machine computation. Considering that such anthropocentric approach could not incorporate the contributions of the nonhuman in design decision-making processes, this thesis has proposed to mobilize the long-muted concept of intentionality together with the repressed subjective faculties (intuition, artistic expression) as necessary ingredients of computational design processes, while at the same time, destabilizing the anthropocentric presuppositions that have ignored the constitutive faculties and effects of the nonhuman agencies in computational architecture.

This study has correlated the quasi-absence of a discourse on the concept of design intentionality with architecture's disciplinary reservation, in other words, with the protection of the concept of intentionality within the limits of an unquestioned hard core. It has been discussed that a significant shift has occurred when the new toolsets

that computational paradigm entails have been introduced into architectural design, reversing the hierarchy from top-down decisions to bottom-up formations. Such a shift has been responded with great interest among architects and designers who went into exploring the emergent properties and generative capacities of these tools. The possibility of an almost autonomous system has led architects to delegate some responsibility for different levels of design decisions, which then induced a recession in expressing designers' explicit architectural design intent and decisions. These intellectual tools that can order massive data with ever increasing organizational capacity have given rise to a technocentric condition that minimized the designers' subjective, intuitive and expressive faculties, while privileging accidental or emergent formations not governed by top-down processes. Hence, a shift from 'form-making' to 'form-finding' has been discussed in the thesis as a first response to the decentering of design intentionality grounded in human consciousness, brought forth with advances in computational tools.

The originality and contribution of this study is multifaced. Yet, primacy lies in the problematization of intentionality in computational architecture and the development of an inclusive and performative model: Moving away from the conventional definition, intentionality has been dismantled and augmented with the concepts of 'agency' and 'action' to acknowledge different forms and degrees of intentionality and to address a complex and distributed form of intentionality which values the contributions of both human and nonhuman agencies.

The thesis has set intentionality as an interface within a human-technology assemblage. The Deleuzian concept of 'affective assemblage' has been introduced to define this human-technology co-operation. Departing from that, a spectrum of intentionality has been visualized in order to illustrate different levels and intensities in which human-nonhuman agencies could co-exist in an assemblage. This visualization has suggested that intelligence exceeds human consciousness and could be identified with an artificial and evolving one.

It has been argued that the long-established anthropocentric account of intentionality, which, according to Werner Rammert, sustained itself as an efficient and simplistic strategy of tradition-building that ignored cognitive and social complexity, has been unbalanced by the advanced and improved design tools that complexity paradigm provided.[273] With this emphasis on the tool, the thesis has articulated on this rupture in the nature of the material support which has altered the way we think and enabled the production of new intellectual objects by revealing that the emergent qualities of computational tools in the design process have refreshed design thinking by subverting the conventional determinacy associated with human-centered intentionality into the indeterminate and unpredictable nature of these intellectual tools. With the aim to understand alterations in the conceptualization of design intentionality in relation to technological advances, the study has presented the concept of 'emergence' as a breaking point, a Deleuzian 'singularity' in digital computation, a concept that has entered the world of design as an exploratory and generative device to inquire into the uncertainties and indeterminacies of computation with an ultimate potential to alter design intentionality by demanding new strategies.

In the conventional account of design and architecture, the assumed dominance of the human designer over nonhuman entities has been challenged by the nonhuman modalities of thought through which the technological tools offer. By postulating an agentic reading towards intentionality for a dissolution of the either-or-condition that appears to be a polarity between human-centered and techno-centered views, the study has exercised a hermeneutical framework which provided a deeper examination of the complexity of the design process and the multiplicity of actors involved, through a holistic understanding of the human-technology relationship that decenters the long-established role of the human designer in emerging human-nonhuman constellations.

Such a holistic understanding of the human-technology relationship requires an examination of the evolution of intellectual tools parallel to the alterations in their

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[273] Rammert. "Where the action is", 78.

properties and capacities. The toolset that the computational paradigm entails created a rupture in the course of architectural design through unbalancing the authorial roles and intellectual contributions of designers and delegating some design decisions to computational logic and calculation capacities of algorithms. The ever-increasing capacity of machine computation sustains its own indispensability in design process, and at the same time, secures a so-called scientific and objective ground and an expanded reservoir of ideas for its users. In this win-win looking condition, the act of computing both separates and integrates design thinking by suspending design action. Originating from the emergent, self-organizing and adaptive behavior of computation that is by nature unpredictable and indeterminate, the moment of delay is charged with possibilities, misinterpretations, mistakes and many other strange encounters that have potentials to create novel and new ideas.

The discussions have opened up a potential space for an account of design intentionality towards distributed modes in the form of hybrid constellations in which intentionality is altered, embedded and distributed between both human and nonhuman agencies. The agentic account of intentionality that this study proposed can be correlated and used as a method to assess and reclaim -another muted concept- architectural authorship, as a response the dissolution of authorship in the computational form-finding paradigm. Such a correlation, that does not seek for a return to the single author paradigm or even a human-centered account, would rather suggests to confront the intricacies of contemporary design complexity and explore methods to resolve it. [274]

Considering the epistemological conflicts and opposing connotations embedded in their definitions, the reconciliation of the concepts of intentionality and emergence has

[274] The initial problematization of this thesis was the altering condition of authorship in computational architecture. For a discussion on architects' design intentionality in relation to the issue of authorship, see: Duygu Tüntaş. "Reconceptualisation of Architects' Intentionality in Computational Form Generation: A Tripartite Model," *Footprint 22: Exploring Architectural Form: A Configurative Triad.* Delft Architecture, Spring / Summer, 2018: 51-64.

been a particularly difficult task. The hermeneutical relationship between the concepts of intentionality and emergence that this thesis has proposed as a methodology with reference to Bruno Bachimont's 'material hermeneutics' has been a genuine contribution of this study. The implication of the emergent qualities of computational tools in the design process has been argued in this regard to refresh design thinking by subverting the conventional determinacy associated with the concept of (human) intentionality and extending it into the indeterminate and unpredictable nature of these intellectual tools.

Remembering the immediate connotations of the concept of emergence –such as the unpredictable, the unthought, and even the unintentional– an opposition can be observed with the concept of intentionality. Recalling Deleuze and Guattari who "constantly remind us that oppositions can be transformed into one another,"[275] the proposal of this thesis is that the material hermeneutical relationship between intentionality and emergence is becoming noteworthy, where the mark of the distinction between the predictable and unpredictable is no longer easily discernable.

The scope of the discussion in the present thesis has been limited to the relationship between the designer's subjective faculties and the emergent properties of algorithmic agency in human-nonhuman constellations. The significance of the concept of emergence for this study originated from its capacity to reshape the designer's intellectual landscape with its own modes and reasonings. The specific focus has been on a few designers who research on and practice extensively with algorithmic procedures, write specific and custom codes for their design and actualization, thereby, claiming to exhibit distributed and impure models in which design intentionality is generated, exchanged and hybridized in the process of continuous feedbacks both from human and nonhuman agency, so that a possibility space for non-systemic, intuitive decisions in computational procedures can develop by engaging with the speculative potentials of computational procedures. Rather than the recognized forms of

[275] De Landa. *Assemblage Theory,* 3.

computing, the study has specifically instantiated the creative use of the code in order to show the potentiality of algorithmic agency to expand the possibility space of design and reservoir of design ideas.

The research has shown that the digitalization of algorithmic processes extended the capacities of intellectual tools and enabled new synthetic configurations to the world of design through emergent properties. The hermeneutical framework between intentionality and emergence that has been initiated in this thesis, opens up a trajectory for other studies and research in which the same methodology can be implemented with different material supports, i.e. design tools, and as the nature of the support of inscription will alter, the findings and conclusions that follow will be different.

On the human-technology interface, it has been claimed that mastery and experience of technological tools enable designers to explore the space in-between the determinate and indeterminate, predictable and unpredictable, rational and irrational qualities and properties so as to challenge both poles in order to reconcile design intent and subjective faculties with computational reason. The space generated in-between is open to be filled with new and novel ideas. Considering design intentionality less as a field of contestation between human designers and the computing machine but rather as one of negotiation, different degrees and intensities of intentionality are seen to become visible and accessible for new and novel ways of design thinking.

Rather than opting for a human-centered or techno-centered conception, the thesis has rendered a distributed conceptualization of design intentionality both by reserving the human agent the indispensable interpretive role and by appreciating the contributions of the computational tools as the support of innovation and novelty in design. With reference to the discussions on Bachimont's theory of a 'material hermeneutics' in general and his account of intellectual tools in particular, it has been stated that a transfer of human intentionality to the organizational capacity of algorithmic agency has created a rupture in the process of encoding designer's intentionality with the mediation of computation and necessitated reclaiming the interpretative lead of human

intentional agency within hybrid constellations from which creative interactivities and unprecedented things emerge out.

In the constellation of decision-making, the human side of the equation constitutes the interpretive position and intervenes in automated processes: The study has placed such a weight on the human in the human-nonhuman spectrum, not because the human is the only source of action, but due to the indispensable role of the human agency with interpretation. It has argued that placing interpretation at the core of human-technology interface will foster new and unanticipated fields of possibility. The exploratory capacity of human-nonhuman interaction has been promoted for their informing one another and expanding the intentional content.

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