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Alessio Erioli

Architectural Design in the Age of Enhanced Artificiality

Il progetto di architettura nell'era dell'artificialità amplificata

Keywords: ARCHITECTURE, AUTHOR, COMPUTATION, AGENCY, ARTIFICIAL INTELLIGENCE
Parole chiave: ARCHITETTURA; AUTORE; COMPUTAZIONE; AZIONE; INTELLIGENZA ARTIFICIALE

“Postmodernism is the times of enhanced artificiality.” [1]

Frieder Nake

This article would like to offer a philosophical overview on the subject of the author in light of the evolution of technology and the explosion of computation with particular reference to their impact on the disciplines of architecture and design. Within this premise though, the scope of many of the presented concepts can be widened to encompass any form of creative process, human and non-human alike. The concept of authoriality, and the relation between design and making will be reviewed under the lens of computation and its evolution, from the relevant historical premises underlined by Carpo and the figure of Leon Battista Alberti to the raise of AI and its foreseeable potential.

Questo articolo vorrebbe offrire una visione d'insieme filosofica sull'argomento dell'autore alla luce dell'evoluzione della tecnologia e dell'esplosione della computazione, con particolare riferimento al loro impatto sulle discipline di architettura e design. In questa premessa, tuttavia, la portata di molti dei concetti presentati può essere ampliata per comprendere qualsiasi forma di processo creativo, sia umano che non umano. Il concetto di autorialità e la relazione tra progettazione e fabbricazione saranno esaminati sulla base della computazione e della sua evoluzione, partendo dai pertinenti preconcetti storici sottolineati da Carpo e dalla figura di Leon Battista Alberti fino all'aumento dell'intelligenza artificiale e del suo potenziale prevedibile.

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INTRODUCTION

This article would like to offer a philosophical overview on the subject of the author in light of the evolution of technology and the explosion of computation with particular reference to their impact on the disciplines of architecture and design. Within this premise though, the scope of many of the presented concepts can be widened to encompass any form of creative process, human and non-human alike. The reference to creative *processes* instead of *disciplines* is not accidental: creativity is considered here as an attitude and, as such, independent from the object of attention or the discipline of application.
There will not be tool names, coding jargon or sectorial acronyms because of their highly circumstantial nature and therefore limited scope. The article also will not show almost any examples, for two reasons: first, because there are not enough significant examples that can eloquently embody the concepts that will be unfolded; second, because those concepts pivot around a specific sensibility for complexity that needs to be discussed resisting the reduction to trivial disputes that untimely examples may induce, such as – for instance – blacklisting specific geometries: it is not a matter of *blobs vs boxes* neither *blobs vs folds*, nor *curves vs lines*, not even *free-form vs planar*. These false dichotomies (which also contain deceivingly inaccurate or outdated terminology) are an appendage of obsolete paradigms, they do not matter to this discourse and they cripple a truly fruitful and productive debate around a creative future for architecture.
Those rare examples that will be shown are prototypical in nature and instrumental to the discourse, they are not to be evaluated with a practical mind as it is not their scope. The implications of practical thinking are undeniably important, yet contingency (the here and now) is their limit as much as their realm, so a lively tension with a broader perspective should always exist: the latter keeps the focus on the global patterns, the former avoids the sublimation into sterility.

AUTHORIALITY

Nelson Goodman posits that all forms of art and disciplines are born as autographic (handmade by their authors); then, some become allographic (scripted by authors to be materially executed by others). The progressive escalation in complexity (boosted by the expansion of one or more of the following aspects combined – the amount of objects involved, their complexity, the number and qualities of the relations connecting them) at some point exceeds the capacity of the single individual to carry out all the steps of a given process.
When this critical threshold is reached, some parts of the process need to be outsourced: this implies some form of explicit notation that must be shared by the involved subjects, which in turn leads to the definition of protocols of communication to encapsulate and organise the necessary information. The problem of notation, and in particular of one that would ensure the identical reproduction of an artwork or architecture, was a very compelling one for Leon Battista Alberti. In his treaties he describes techniques for the exact reproduction of paintings, sculptures, maps and architecture that do not need talented manual labour, relying on mechanic processes that are nothing short of blueprints for digital screens, laser scanners and plotters.
Carpo makes an interesting case for Leon Battista Alberti as the inventor of architectural design: Alberti had an obsession for notational identicality, influenced by Gutenberg and the impact of his invention for literature: a manuscript copied by amanuenses always had some modifications and variations performed by the transcriber, while with the mobile character machine it was possible to reach, for the first time, a final state.
Similarly, a work of art was something alive in its making, susceptible of mutations and changes (see the *pentimenti* in paintings), and the products of architecture were not only the product of construction processes as much as design, but they often admitted substantial changes and modifications over time without the notion of an original. Carpo's thesis is that Alberti's obsession for identical reproduction accidentally created a concept that was unknown before that time: the original, final version of a work; moreover, this final version is not a physical object anymore, but a product encrypted in a notational system, ready for exact reproduction.
Notation thus becomes separate from construction, incidentally sanctioning also the figure of the author. Filippo Brunelleschi (from whom Alberti's theory took its cue) already claimed the intellectual rights to their works, but the novelty of Alberti is that the final product is complete already in its notational form, the description in words and images that allows its exact reproducibility.[3]
The impact of this turn rippled and propagated over time throughout the entire discipline of architecture, causing a rift between designing and making that dramatically accelerated with the advent of the industrial revolutions, leading to a familiar scenario: a separation between design and making in which all design lies in the conceptual phase and making is a pure reflex, a mechanical execution for the uncompromised materialisation of the concept.
But, as always, there is a catch: codification of any form implies a system of mediation, and all mediation involves modes of storage, manipulation, and transmission.[4] Kittler points out that in order to comprehend the entire system of mediation, one must not stop at the art form that appears to hold the content and consider the relations between storage, manipulation, and transmission. One crucial point Kittler makes is that the computer is the first technology of mediation that automatically combines storage, manipulation, and transmission into a single system. Carpo makes a similar remark about 3D modeling, when he affirms that it encapsulates both design and making as the information stored and manipulated preserves three dimensions: the act of modeling a cube in 3D is very different from drawing one on paper, as the latter implies a notation to reduce one dimension, while the former is a real (albeit not physical) cube. In addition to this, digital technologies can process and manipulate information in such ways that difference and variation can become programmed design features. In architecture, this spells the

end of mechanical standardization, and, with the simultaneous possibility to mobilise materiality and machines within the same process, of the Albertian design/building authorial relation.

ON THE INTERCONNECTIONS BETWEEN TECHNOLOGY AND AUTHORIALITY

Technology has always defined the operational boundaries of the design space, and its characteristics also shaped the features of the realm of possibilities it simultaneously opened: in the age of orthographic projection and scaled drawings, if something was proved to be difficult or impossible to represent, then it was not built either.

It is common to think of technology in substitutive terms, with a new technology completely replacing an existing one; this, however, is a typical mistake caused by an extrapolation of linear thinking. Instead, new technologies restructure and reshape the existing landscape (including the human) in non-linear and more intricate ways. In light of this scenario and in order for a project to be relevant and appropriate, it should open itself to shift from a predictive stance to a speculative one, imagining opportunities by means of projective inferences, not unlike what good science fiction does. According to sci-fi author Ursula Le Guin, extrapolative science fiction is always dystopian as it amplifies only a single factor without considering paradigm shifts and non-linearity: you always end up with too much of something (dystopia).

The same can be applied to substitutive logic and many other logical fallacies implied in a predictive design process: they are extrapolative as well. [5]

Technologies should then be regarded as a source of opportunities, engaged with an open-ended mindset. Something that Frank Lloyd Wright firmly believed in as the path to innovate in architecture:

> If I was to realize new buildings I should have to have new technique. I should have to so design buildings that they would not only be appropriate to materials but design them so the machine that would have to make them could make them surpassingly well. [6]

He was also aware that creative freedom is achieved only through mastery: "The Machine is the architect's tool – whether he likes it or not. Unless he masters it, the Machine has mastered him".[7] For their inherent capacity to reshape ways of thinking, machines cannot be just relegated as executioners of the construction, they are part of the process of design itself.

Wright had the industrial process machine in mind, but the sentence might well be extended to digital technology as *program or be programmed.*

Technologies also define their operational limit from the environment in which they are projected onto, and, in doing so, they reveal their own shape just as the reflected light of a torch in a dark room reveals the profile of the torch itself. More concisely, environment and technologies mutually reveal their shape from their reciprocal interaction. The operational possibilities and boundaries that result from the projection of a technology in an environment define a network.

As technology defines the operational boundaries of the design space, its advancements push those boundaries and widen that space, in a movement that is not one of endless expansion but one of continuous restructuring, enabling paradigm shifts. One that taps into the creative potential of contemporary computation-based design approaches and allows to directly choreograph and operate at the microscale morphology and program autonomous behaviors in a system.

Technology also shapes culture in symbiotic paths, up to the point that, borrowing from the concept of the apparatus in the same way that McKenzie Wark does from Karen Barad, the properties and capacities of the apparatus itself at work define how the cut between subject and object is shaped through the phenomena it engenders: the consequence is that there is no good way of discriminating between the apparatus and its object.

No inherent subject/object distinction exists. There is an object-apparatus-phenomena-subject situation: when the apparatus is mobilised, it produces the cuts which make these appear to be separate things.[8] For instance, when considering the impact of robotics in architecture it is not just the case of a technology automating existing processes, but since architecture is entrenched with technology and its outcomes depend on it, any serious innovative thinking considers how it redefines the entire discipline and all the terms involved: redefines the tectonics – this is where, by building the relations between morphology and metabolism, morphologies intercept the material dimension; reshapes the design and realization process – builds bridges between design and making, computation fuses the once separate realms and transforms them bringing more sophisticated and complex abstractions and systematizations; questions the author - by author we can think of the philosophical persona, the subject that takes decisions.

But technology needs to be coupled with an equally apt theoretical paradigm and design approach, or its potential will never blossom. As Wright said, a design shift is necessary. And he was a proto-algorithmic architect himself. [9]

COMPUTATION / RIFT

The different pace at which technological propagation and paradigm renovation progress causes a rift; computation acts as a catalyzer, accelerating processes and exposing it. The rift affects the design ecology polarising it towards two opposite attitudes: tecno-fetish on one side: characterised by a selective ignorance on theory and/or an overinflation of the technological dimension; neo-luddites on the other side: here selective ignorance acts on technology, with a consequent rejection of novelty and rebound to obsolete

theories out of nostalgia or bewilderment (case in point: the recent trend that sees the return to 2D painting, collages, watercolors - but on Photoshop).
It is then worth spending a few words on a definition of computation that is instrumental for a contemporary debate that does not stagnate into the aforementioned phallacies, starting from a necessary premise: concepts should stay technology-neutral, or better yet tool-neutral (they should not need to lean on the description of one particular implementation of technology) to maintain a necessary level of abstraction and generality.
For example, a constructor agent might well make use of a robotic arm, but its definition should not bind itself to that specific instantiation of technology.
Likewise, and to avoid confusion, computation (and not computers like laptops or other comparable hardware) is the object of speculation investigated here, with regards to its implications in architecture. Computation can be defined as information processing; it tries to compress infinite quantities of data in finite sets of operations.[10] When it occurs on the mineral or biological world we witness operations that remain in the realm of the computable (a current in a river is a sorting machine for rocks and pebbles of different shape and weight, a cycle of respiration processes chemical and energy information across different systems and subsystems); incomputability is what causes the collapse of a system. The introduction of an explicit mathematical model exposes the limits of computability (as compressibility/reduction) and introduces abstraction and notation.

THE PERSISTENCE OF PARADIGMS

The relation we have with technology is symbiotic: the tools we make in turn reshape our mindset and our gestures (Merleau-Ponty and Adorno already admitted the possibility of objects restructuring the subject by incorporation and boundary remapping). Their influence is in fact so strong that in some cases their persistence transforms them into mere accessories to a gesture. The act of drawing is a remarkable example: the gestures induced by the primordial tool persist, resisting even the computational paradigm shift.
Sketchpad, the first example of a Computer Aided Design software designed and written by Ivan Sutherland at MIT in 1963, is an extension of an existing paradigm: the drawing board (Fig. 1).
The abstraction of the notation required for programming, however, transcends this paradigm inertia: software is assembled out of basic rules, procedures and criteria – which are behavioral and organisational in nature. In the case of *Sketchpad*, the behavioral nature of computation is concealed under the appearance of a familiar paradigm (a wolf in sheep's clothing), with the interface acting as a system of mediation. What lies underneath though is the key to access a powerful change in the design process: the shift from an overarching plan to distributed decisions in form of

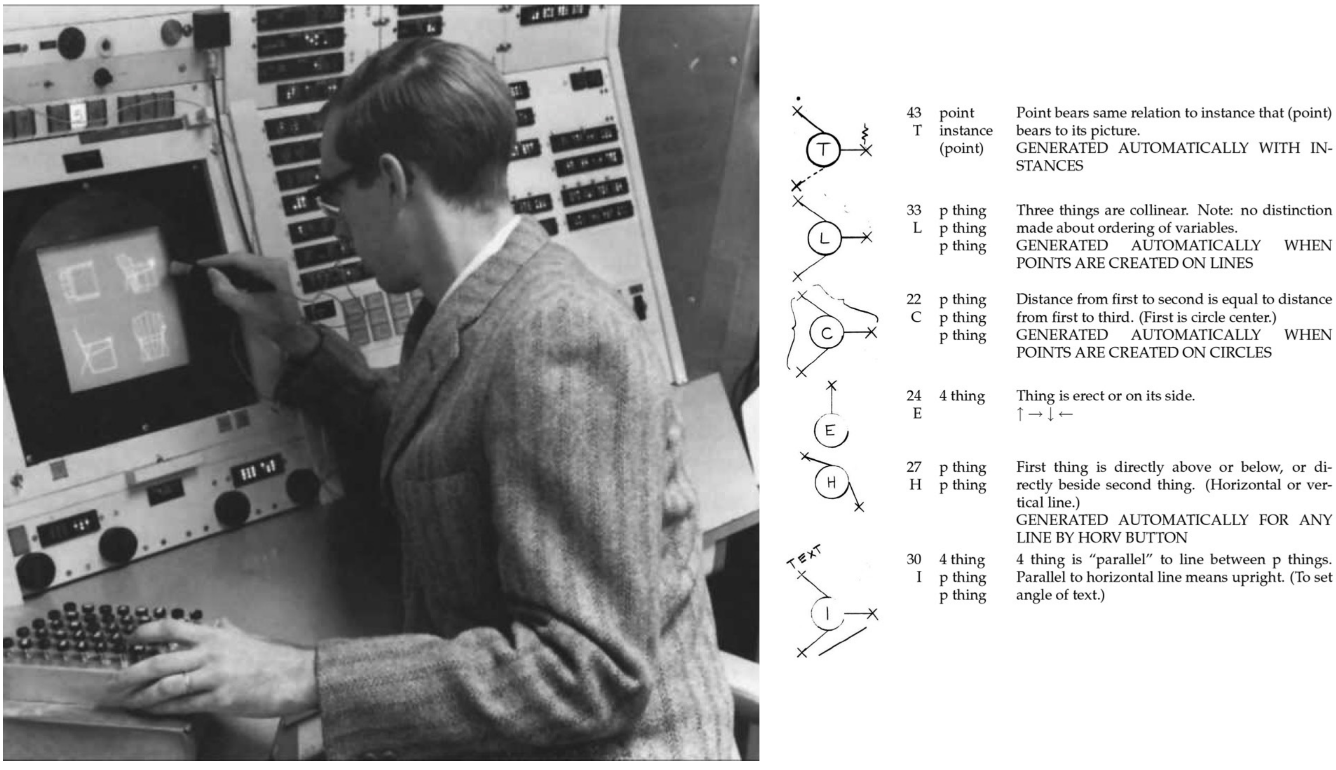


Figure 1: Ivan Sutherland operating Sketchpad and some of the software's behavioural diagrams (1963). Collage by the author.

Figure 2: Wall Drawing #786A by Sol Lewitt, diagram and execution (2018). Photos by author.

behaviors. And yet, something is still missing: any CAD system can assist and automate processes, but automation without feedback, something that is nothing more than the reflexive execution of instructions, only shifts the Albertan divide (with some parts pertaining to the *conceptual* domain moving into the *execution* one), but does not dissolve it.

VON NEUMANN'S MACHINES

The idea that machines are passive tools is a stubborn offshoot of old determinism, a reissue of linear thinking where cause and effect are always in a clear and detectable relation.
This has been of course disproven by the theory of complexity, and yet it is surprising how an outdated paradigm still thrives in the field of architecture. Emergent complexity (an outcome whose properties exceed and cannot be deducted in advance from its input data and rules) can be achieved through the iteration of simple rules; this has been demonstrated over time in science and the arts alike: the Belousov-Zhabotinsky reaction, Craig Reynolds' flocking model and the discovery of collective behaviors (not to mention that "swarm intelligence" – a term that describes how collective species coordinate and show intelligent behaviors beyond the capacity of the single individual – was coined by Beni and Wang in cybernetics) in the sciences, and the work of Casey Reas, Zach Lieberman and many others in the arts. John Holland provides some insight on how to surpass the mechanical paradigm and the limited conception of a tool as inert executor.
A brief inquiry on emergence and the dismantling of its criticism provides another key to overcome the limits of representation in the face of complexity and understand the necessity of computation.
Up until the 1950s some scholars held a position of refusal of emergence, convinced that machines could not self-reproduce (thus, criticising the possibility of understanding emergence from the study of deterministic relations) justifying the impossibility of its scientific demonstration with a reasoning "based on the concept that a machine, to reproduce itself, would need a description of itself. But that description would have to include a description of the description, and so on, ad infinitum". [12]

A position that collapsed in front of Von Neumann's model of a self-reproducing machine. It is worth noting that the birth of cybernetics and the experimental study of simple machines with stimulus-feedback interaction capabilities proved fundamental in the direct observation of something impossible to detect from the linear deterministic paradigm perspective: emergent properties.

IDEAS/MACHINES/ART

The ideas of Von Neumann and other prominent figures of that period (Alan Turing, Claude Shannon and Warren Weaver – to name a few) stimulated the sensors of a group of artists among whose was Sol Lewitt, who claimed: "The idea becomes a machine that makes the art". [13]
Lewitt is fascinated by the creative possibilities of a relentless machine (an abstract machine, that is, a finite sequence of instructions); his *Wall Drawings* are algorithms, ordered lists of directives on how to produce the artwork that are subsequently enacted

by others and produce different results at each installation (Fig. 2). Lewitt (as well as other fellow artists like Vera Molnar) wants to question, among other things, the figure of the author and the art piece, and the cut between the acting subject and the object of attention in the creative process. Who is the author? The one who writes the algorithm? The algorithm itself? What about the crew that materially executes it?
Nothing in the algorithm leads by pure deduction to imagine the final outcome and the aesthetic experience that ensues. Casey Reas strongly influenced by Lewitt's figure and his wall drawings, compares an algorithm and its enactment respectively to a musical score and the experience of actually playing its corresponding music: while the score contains all the elements to enact the performance, it cannot deliver the experience itself.[14]
More importantly, what Lewitt prefigured with his works is that as the technologies we use grow more complex and capable of autonomous processes, the more the decisional process disgregates and is redistributed at a granular level and operates over time. The temporal dimension enters the process through the concept of iteration and, together with the nonlinear network of distributed decisions, generates an irreversible history. Thus, an idea cannot be conceived solely in a single moment and monopolised by a single subject anymore; the object-centered, all-encompassing closed formulation of representation gives way to simulation: the process is equally important, as it captures the dynamics that generate the object itself as a result of interacting relations over time. Likewise, the true creative power of computing lies in its pervasive incorporation in the decisional process, from thinking to making, unfolding in time iteratively. And that can truly happen by giving in to its way of thinking: thinking like an (abstract) machine.

The concept of ideas becoming machines, even if explicitly formulated by Lewitt, can be traced across disciplines. Richard Serra in art, Antoni Gaudì, Frei Otto, Heinz Isler and others in architecture, built machines to mobilise materials in order to generate shapes and organisation. Frei Otto and Bodo Rasch named this use of material as an analog computer (as the shape is the result of material computation – the material is a structure that processes forces as information, resulting in a shape) form finding. Form is not a preconceived mold to impose over an inert goo, but it is the result of processes of formation that activates the self-organizing potential of matter, the latter being more accurately captured by Spuybroek's description as "being in transit, as neither being raw substance any longer nor having yet entered the field of finalized forms".[15]
Computation is a concept that predates and extends beyond the computer as a tool, and it is important to make a distinction between "computational" and "computerised"[16] as a matter of methodology rather than the adoption of a specific toolset.
This difference can be better explained in the comparison between two architects, Antoni Gaudì and Frank Gehry. Gaudì relies on the construction of intellectual models mobilising material through mathematical and geometrical understanding, thus relying on computational methods: the Sagrada Familia hanging model is an example of simple geometrical relations applied to a material, activating a form-finding process in which complexity is the result of the resulting network of iterated operations.
Gehry relegates computers into the realm of the mere technical passive objects, relying on the conventional paradigm of humans' unique and unrepeatable abilities of intuition, talent, sensibility; his models are mere reflections of human operations, involving computers to generate digital replicas and manage technical issues. His methods are thus computerised and not computational, still anchored to the persistence of an anthropocentric paradigm of creativity.

INHUMAN TENSION

There is another substantial difference in the cases above: while Gehry's models subject machines to a traditional idea of human creativity (and thus confining creativity to the limits of a single subject-artist), Gaudì, Serra and the others included machines as an active part in their process of creation, accepting its inevitability as a necessary means to resist easy figuration and immediate implementation, expanding beyond human limitations. In other words, machines (or the apparatus) allowed them to explore the nonhuman dimension.
McKenzie Wark quotes Karen Barad in defining the apparatus as inhuman, the probe that allows us to peek into the non-human: "the cuts it makes, the phenomena it records and communicates, that produce sensations from a nonhuman world. The inhuman mediates the nonhuman to the human".[17]
Searching into the inhuman perspective requires a certain amount of tension: a tension that challenges our comfort zone with uncomfortable findings, that are not reassuring. Because if they are, there is little creative potential there; Richard Serra again: "I have to kind of invent new strategies in order not to go back to

something that's just a reflex action".[18]
As abstract as this perspective might seem, it bears unsuspected implications at the ecological level: while we are part of nature, nature does not begin and end with us – nature is not human.[19]
The sooner we come to terms with this idea the better; no matter how comforting, anthropocentrism attempts only hinder a more comprehensive and fruitful ecological understanding of our actions. Let us not forget (again) that one of the most paradigm changing insight on biological system came from the study of synthetic, nonhuman machines (cybernetics).
This understanding of technology (as the 7th realm of life) lies at the foundation of our symbiotic relation with it [20]: if technology is often the problem, it is also always the solution (as Cedric Price famously said). That does not mean its sufficiency though, merely its necessity: we cannot escape technology, and any way of improving our human condition is through it, not renouncing it. If anything, a crucial problem of the current age is the lack of a proper philosophy to map and make sense of this symbiosis without shrinking back to obsolete and scarcely useful paradigms.

PARAPHRASING LEWITT – OR THE DOMAIN SHIFT TOWARDS ARCHITECTURE

The first step in this direction is then to build and use an apparatus to probe the nonhuman in architecture, as Lewitt did in art. Paraphrasing his sentence: ideas become machines that grow the architecture.
Following a Deleuzian strategy, the specificity of architecture (what makes it different from other arts, or its interiority) can be ascribed to what is singular within its medium: when treating cinema, Deleuze considers narrative as a secondary dimension (as it is shared with literature), treating it instead as an invention and experimentation of moving images. Similarly, architecture can be approached as an invention and exploration of voids created by enclosures of matter, that investigates what space can do. A design operation transduces itself in programming behaviors that produce enclosures of matter around a void. [21]
Features and properties will be the result of the enactment of coded relations in the machine (or, more generally speaking, machines – with varying capacity for autonomous decision), that simultaneously shape those enclosures and its correlated void.
Building these machines means embracing their inhuman nature, and accepting that the designer enters a larger ecology in which cognition is reshaped during the process together with the object that is constructed; more generally, the process reshapes continuously the subject-apparatus-object interrelation and mutual boundaries, challenging classical and established notions of clear cause-effects relations. This causes a necessary reconsideration of the design process itself: in a typical linear design process, one that adheres to the Albertian divide, decisions are all concentrated in a single initial phase, producing a complete prefiguration (conception) that then is brought to the real world with the least possible deviation (materialisation); the conception phase also defines authoriality, following the design/making separation doctrine.
Notably, there is very little abstraction between intent and outcomes: conception is essentially based on prefiguration, the limits of what can be done are one and the same with what can be imagined.
In a computational approach, the decisional process is distributed within the system at the metabolic level, producing a causality network with multiple possible branchings at each step. An action can trigger multiple effects and consequences; conversely, single effects can be the result of multiple causes. The nonlinear nature of these distributed decisions resists the reduction of their operating logic to a single, encompassing principle operating from the outside that regulates the global properties of the outcome.
What happens to authoriality in this restructuring of the process? It certainly does not disappear, but it shifts and distributes as well, binding itself to the decisions that propagate at each iteration. In the words of John Frazer: "The minute you start encoding things you put intentionality into things". [22]
More specifically, the nature of authorship, or intent, within computation-based design processes can be categorized within what is being encoded as either criteria or procedure. [23]
Criteria are inherently stable, boundary-like, as they constrain the possible realm of the artifact. In contrast, procedures are inherently speculative, as they are concerned with the conditions of operation rather than conditioning the outcome. Procedures and criteria form the computational apparatus, which places itself with a necessary degree of abstraction between the design intent and the artifact, creating a space that enables an emergent outcome through the interaction of design processes. Prefiguration is far from being a dominant operation, resulting more often than not an obstructing factor in the exploration of possible emergent scenarios. Defining

the rules of engagement for a system that unfolds over time and watch how these rules play out is precisely how simulations work. When applied for analytic purposes, they work as a map to an existing territory (the phenomenon that is tentatively reproduced being the territory); but when used in a speculative stance, the map precedes and engenders the territory itself: once the simulation apparatus is built, it needs to be explored to see what sort of territory is engendered. Baudrillard refers to this reversal as precession of simulacra, and to the engendered territory as hyperreality. [24]

AESTHETIC OF DECISION/COMPUTATIONAL CRAFT

Algorithms, to give a more suitable name to those abstract machines specifically located within the realm of computation, are not just mere tools: they incorporate intentionality and distribute it across the process with their enactment, causing effects that can then be experienced at the aesthetic level (the experience involving the totality of our interconnected senses). Algorithms are modes of thought in their own right, and the logic they incorporate becomes an aesthetic operation.

If self-organising and emergence are the means through which higher form of complexity can be exploited, their outcomes are not automatically *correct* or useful within a larger process; they require continuous exploration and channeling, by means of interacting with one or more decision-making personas. It is in the articulated and distributed web of decisions (both encoded and as a result of assessment of the outcomes) that we can find intentionality and authoriality, neither confined in a single subject or moment out of the process history nor cutting off making from design. In the elegant words of Shaviro, “what we need

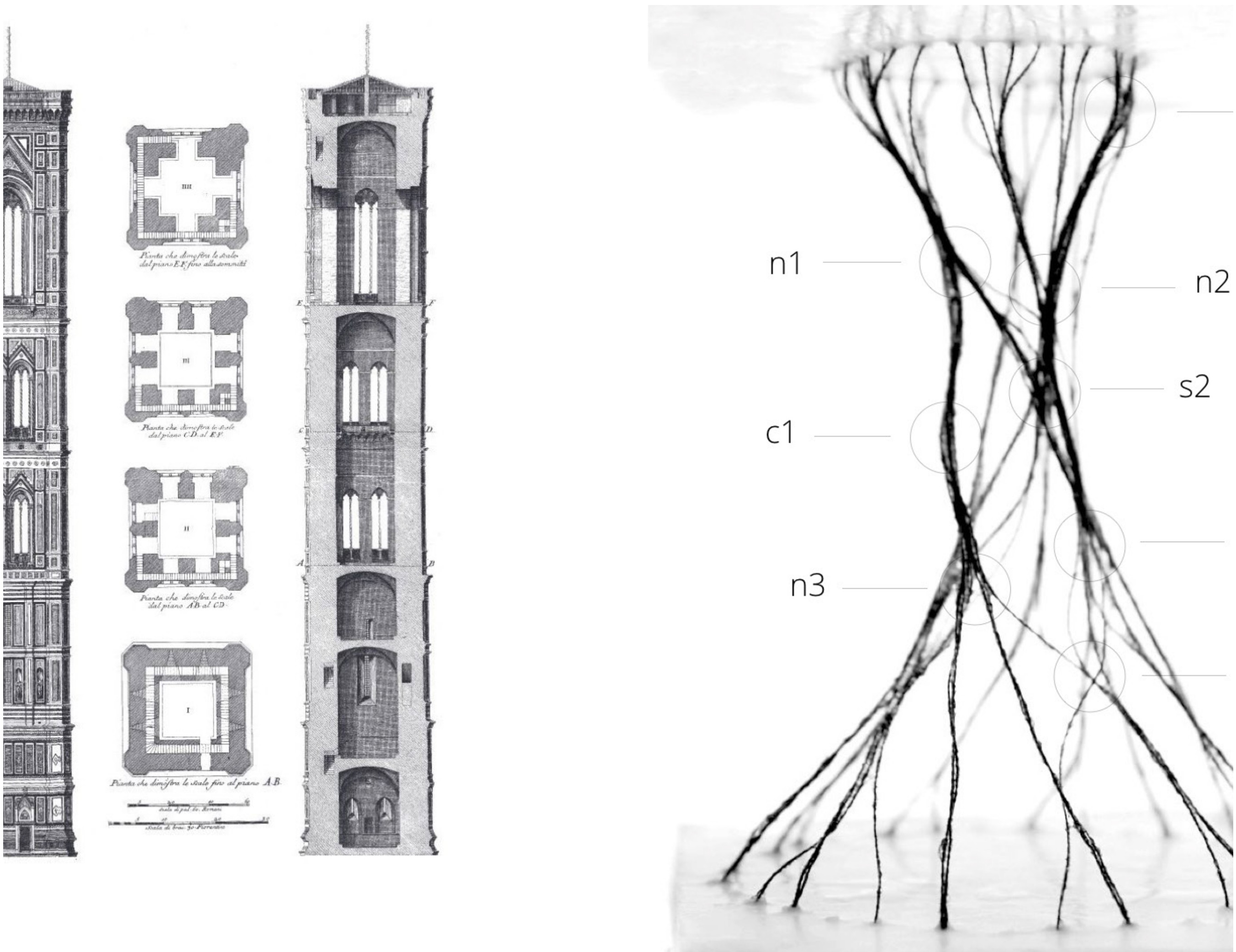


Figure 3: The Campanile di Giotto vs. Frei Otto’s fibrous tower model: a tectonic of objects vs. a tectonic of behaviours. Collage by the author.

is an aesthetic of decisions" in a frame of emergence and self-organisation. [25]

The adoption of computation is then far from being an homogenising and objectivising horizon, it requires the exertion of an activity, and an activity involves the application of a certain sensibility in order to gain fluency and potential for expression. In the applied arts, the exercise and discipline of sensibility constitutes a craft; John Ruskin defined it as the free flow of ideas through the hand of the artisan. The concept of craft can be applied to computation, but first it must be rescued from the confined realm of manual or human activity: craft can be defined as an accumulation of knowledge that sublimates into sensibility. It is neither tied to the use of hands (although it is haptic, it requires a body and thus involves aesthetics), nor a unique human trait: machines can also learn and refine the same kind of sensibility.

Computation itself is not a tool, it is a design medium, using the term with the *duplice* meaning of means and territory.

BEHAVIORAL TECTONICS

In the shift from form to formation, a pivotal role is assumed by the concept of assemblages and construction. Assemblages are defined by Manuel DeLanda as wholes that have properties that exceed their constituent parts, but differently from organisms those parts can have an individual identity and might be detached and plugged into a different assemblage in which interactions are different. [26]

Construction is the process of constitution of an assemblage, regarding both the collection of necessary parts and the establishment of the relations of interaction. As such, it differentiates itself from mere execution as a purely mechanical act of building: construction is about organisation and establishing communication protocols between parts. In this regard, a key concept for the declination of computational-based approaches into architecture is that of tectonics, where forms and properties emerge from the interplay of simpler entities forming assemblages, as opposed to a concept based on stereometry, in which shapes are imposed over inert matter. Stereometry works by subtraction, while tectonics works for addition. Tectonics is here defined as the realm in which the relations between formal organization and internal logic of a system are established [27] or, in Lars Spuybroek's definition, what articulates massing, structure and texture within a generative system of relations. [28]

Spuybroek provides an updated perspective on Gottfried Semper's classic tectonic categories (earth, wood, textiles, ceramics), interpreting them not as fixed entities but as behavioral ones: massing, structure, texture, fire as the respective realms of action, construction, perception, sensation. This interpretation allows a behavioral reading of tectonics and related properties: instead of identifying structure, massing, surface or ornament as objects or separate subsystems with specific functions (promoting an essentialist classification of separate categories that misses the dynamics that render emergent properties detectable), these can be read as behaviors or conditions. Certain parts of the assemblage might cooperate and behave as structure, as massing, etc.; a specific part might simultaneously participate in more than one behavior and/or in different ones according to its relative placement and set of relations in the whole. This mode of reading tectonics does not negate the previous one, rather it expands its scope and applicability.

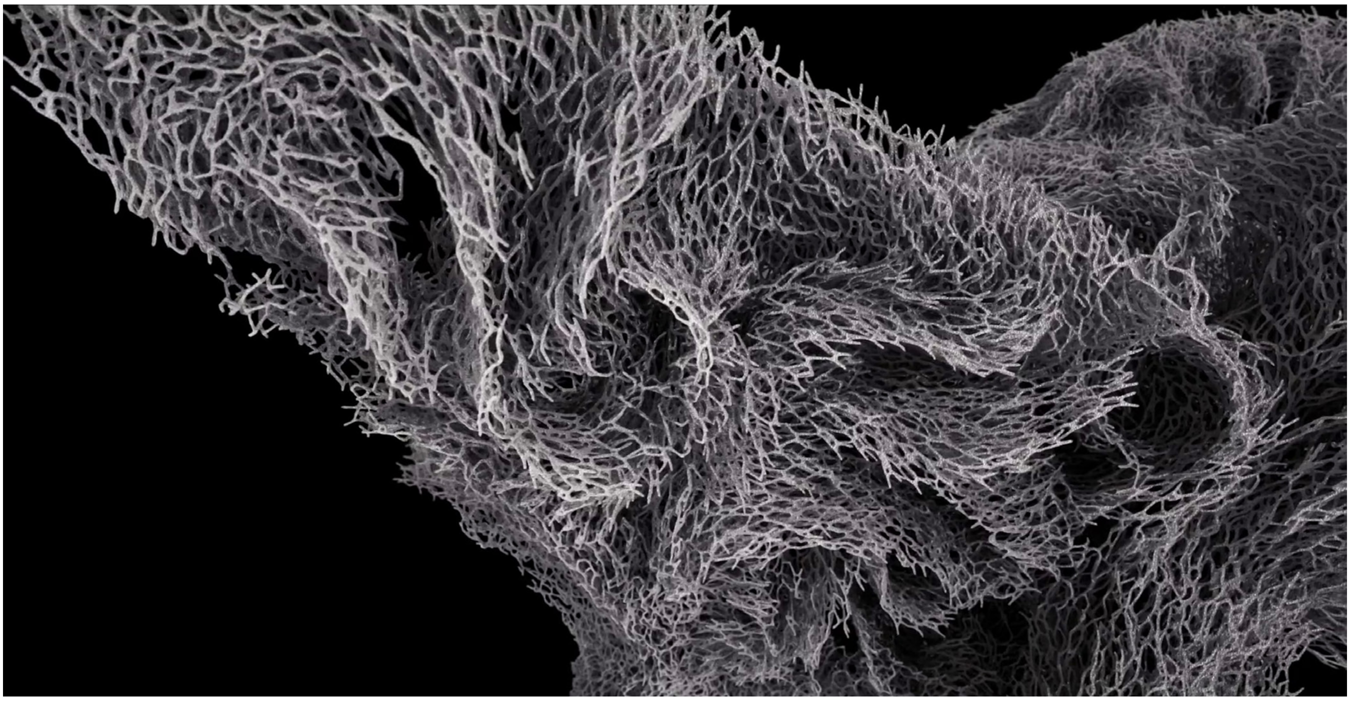
As an example, we can compare two vertical architectures: the Campanile di Giotto and a study for a tower by Frei Otto (Figure 3).

The former is a canonical example of Renaissance architecture, with identifiable parts that can be precisely framed for their unique tectonic role, while the latter resists this essentialist classification: there is no discernable object or subsystem (something that can clearly be identified and taken apart) forming the structure, or the ornament, or the enclosure; it is the behavior of the elements as a whole and the conditions that emerge in the sub-regions that seamlessly flow into one another without losing heterogeneity and readability. But if Frei Otto's study eludes the classical reading, a behavioral reading is possible also on Giotto's Campanile: behaviors are clearly readable, and in this case they are encapsulated into specific objects. A behavioral tectonics provides a more general tool for the reading, interpretation and classification of assemblages that accounts for complexity and emergent properties.

BEHAVIORAL CONSTRUCTION/OPEN ENDEDNESS

Construction is thus an essentially behavioral process, that implies the iteration over time of relations and interactions, codified information that transduces itself into other information of a different nature and/or an action. Morphological arrangements and internal organisation dynamics stem from these iterated behaviors: their propagation, the multiple feedbacks received and the reverberation of information on the cognitive processes of the system (which includes the environment as well) produce a variety of possible options for the formation of architecture through behavioral programming. Algorithms are generatively tied to formations, as they incorporate thought and action as two sides of the same coin, thus bridging the design-making existing divide; a computational approach not only resonates with these paradigmatic foundations, but it dramatically accelerates them.

What is the goal of this acceleration, or how can it be directed? In many contemporary applications and cases, especially those that are appropriated from engineering, there are tremendous misconceptions and flawed practices with regard to concepts of intelligence and optimisation that skew and misdirect the inherent potential of the borrowed strategies. A particularly pervasive and problematic one is the application of optimization at the global scale, through



the use of Genetic Algorithms (and, more recently, crude applications of machine learning techniques) as a design driver to control a whole; its faults lie in the assumptions, not the method in itself.
One of such faults is assigning it a presumed objectivity: optimisation tends to find an optimum by minimizing a function of potential, but to do so it requires a precise definition of the context and boundaries of a problem as well as a shape of the space of possible configurations that admits one single solution. Both of these conditions are not necessarily possible, and they are always obtained by sacrificing the problem's inherent complexity to some measure. Moreover, this is a misunderstanding of the principle of minimal effort, which does not state that systems are optimised by absolute minimum expenditure, rather that an economy of means is a constant, yet open-ended trend: it is related to the dynamics of operation and accounts for adaptability, change and transformation. The ultimate aim of using generative processes should be a radical openness, speculative and open ended, exploring the space of possibilities through the simulation of non-linear systems endowed with agency starting from initial direction vectors. Intelligence is searched as an emergent property of the system and its interaction with an environment, encoding designed tectonic behaviors in the agents that act at the metabolic level. Biology provides a plethora of case studies in complexity, formations, assemblages and construction driven by behavioral iteration and of the intricate relations between form, organization, structure and the anatomy and behavior of constructor agents.
Fire ants can build structures like rafts and bridges by using their own bodies as building blocks: the constant exchange of information among peers generates a collective formation and ensures that the formation itself is adaptable and evolves over time. The resulting assemblage is vague (lacking determinacy, but not internal logic) and anexact (rigorous, yet open ended). A spider web is the consequence of its own body actions and anatomy interacting with material properties and environmental constraints: the tension in a single rope is constantly probed and the span of the spiralling thread is measured by leg proportion. Shape is the outcome of behaviors generated and applied to the interplay among constructor anatomy, its actions and material properties: they constrain and engender techniques and thus the channel the possible realm of the outcome. Weaver ants hold aphids (which they breed as symbiotic specie) in their jaws and, by tapping them with their antennae, stimulate or stop the secretion of a sticky substance that is used to create fibrous membranes holding together the leaves forming their nest. Behavioral programming occurs also in biology: animals programming other animals as tools.
The interesting angle on these examples is the organised complexity that arises in the constructions out of the iteration of a few basic instructions enacted by simple agents; it is the possibility to access and mobilize this complexity in design that is sought after for architectural speculation. The Nine Elms Bridge project by Roland Snooks represents an archetypic example (Fig. 4). The rules governing the agent bodies do not try to reproduce a particular phenomena occurring in nature: algorithms and rules (procedures and criteria), with their own intrinsic

Figure 4: Studio Roland Snooks, - Nine Elms project -, frame of the video shown at the Coder le Monde exhibition ,- Centre Georges Pompidou (2018). Image © Roland Snooks.

coherence are the map that engenders a territory that needs to be explored and navigated. The result is an assemblage whose irreducible complexity lies in the large number of parts and the emergent organization they give birth to, resisting reduction to pure function, structure or any single tectonic category.

AUTHORIALITY IN THE AGE OF AI

The distribution of decision across the design process leaves the question of authoriality as open as it was when Sol Lewitt first raised it with his Wall Drawings, possibly even more: even if someone writes an algorithm, the outcome generally exceeds the capacity of that individual to conceive, and thus the authoriality cannot be fully claimed. To make things more intricate, the raise (or, better, the resurgence) and pervasive diffusion of Artificial Intelligence, with machines and systems with ever increasing degrees of human and non-human intelligence (and sensibility), presses further the question: who, in the framework of AI and thinking machines, is the author now? If decisions are the basic element of intentionality, who is the subject taking decisions?

To try and give a final answer to this question would be a philosophical mistake; it is a question that instead obliges a reflection on what certainly is left out: the figure of a single Author in the Albertian sense. Authorship, intention, and by consequence policies are now embedded in the steps of the process; the consequences propagate simultaneously at the individual scale (the role of the human in design) and at a larger system scale (technology, governance, politics, and potential future trends).

A good start might be in considering the intricate and uneasy relation between technology and art. In its arc from its appearance to its naturalization, technology is first adopted, then ostracized, until the moment when it becomes technique: "is this (authentic) art?" – the question inevitably arises when a manual task is outsourced or absorbed by technology.

Then, in an equally inevitable consequence, it is found out that art (and craft) shifts, more often than not in more interesting realms, if only because those realms are more in touch with the current reality: they are more apt to describe and reveal its truths by means of their constructed fictions – which is one of the most important functions of art. The case of Georg Nees and his 1965 exhibition *Computergraphik*, which hosted a collection of the first computer generated drawings, has become a classic: during the opening one of the attendants (an artist-professor) asked Nees whether he could make his computer (a program) to draw the same manner the artist was drawing, to which he answered: "Yes, of course, I can do this. Under one condition: you must tell me how you draw". [29]

The question of course raised even on that occasion, and raised once more[30] in the occasion of 2018 exhibition Gradient Descent, hosted at New Delhi's Nature Morte gallery, "a group exhibition featuring works created entirely by artificial intelligence" (Fig. 5). [31]

Deciding whether the artwork defy or are included in any of the current definitions of art is not of interest here; it is far more interesting to speculate on the potential for novelty that AI might bring. Along the same conceptual line of the precession of simulacra, the internal coherence of the encoded system ensures a rigor of operation, and thus a systematicity which is the founding characteristic of communication and construction alike. In short, it can be used as a means for creation.

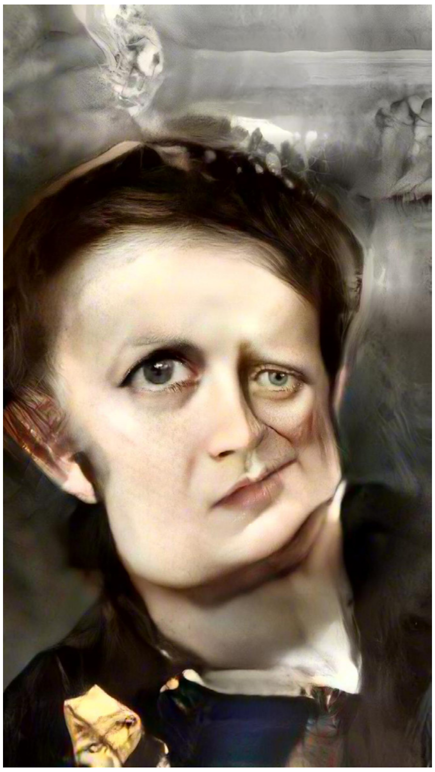
If Convoluted Neural Networks (CNNs) need an underlying environment to operate (a source of information to read - as in almost all works included in the Gradient Descent exhibition) and thus are so far confined to a replication of style at best, a more promising perspective is coming from General Adversarial Networks (GANs), conceived by Ian Goodfellow in 2014. In a brutal synthesis, GANs pits two different neural network against each other: a generator and a discriminator, with the former trying to fool the latter.

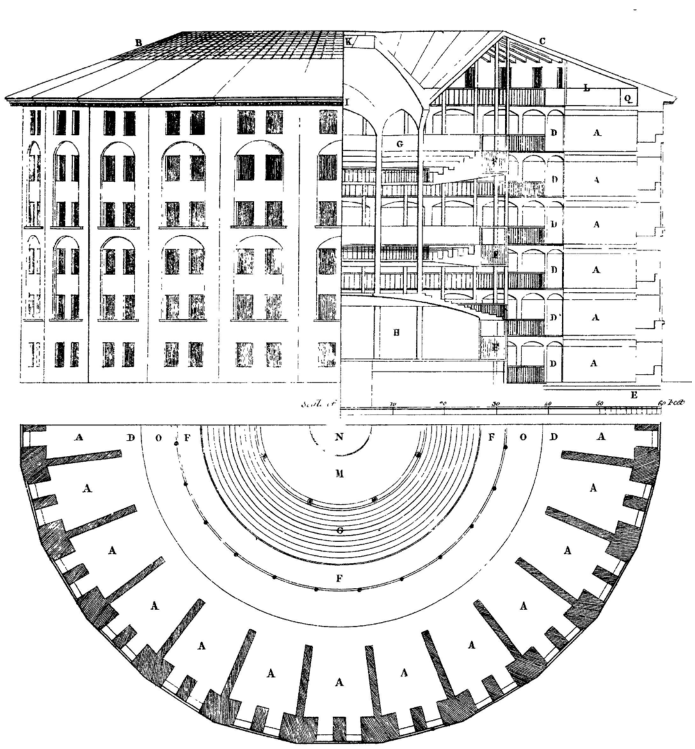
This competitive nature has produced works that defy the notion of limit between reproduction and creation (from realistic photos of non existent people to the surreal nudes of Robbie Barrat) in more than one way: Barrat shared his code as open source, and a few months later at Christie's an AI generated artwork (the Bel Ami portrait) which looks suspiciously as a bare execution of the shared code (just on new data) is sold as the first auctioned AI art. Again: is the author the writer of the algorithm or the algorithm itself?

Ensuing polemics aside, the truly central question lies in the trend of progressive expansion of machines (robots and algorithms alike) in what were considered exclusively human domains. The typical loop of this expansion foresees a "robots/machines/algorithms will never be able to" kind of declaration, swiftly followed by the announcement of a machine that was able to. Computer vision is a pretty clear example in this regard.

In Chatbot le Robot, Pascal Chabot exquisitely frames this trend in the form of a conversation with a software robot who wants to be recognized as a philosopher. The chatbot describes how man places himself in a scale in between two opposite ends: a god/demiurge (the universal creator) and the animal. But intelligent machines do not fit anywhere in it, they are something entirely different, they represent an ontological anomaly. An anomaly that is eroding a definition of human that is apparently shrinking: after being deprived of the center of the cosmos by Copernicus, biological singularity by Darwin, the mastery of his own mind by Freud, now robots are depriving man of the role he gave himself since modernity, that of lord and master of nature.[32]

Pascal Chabot addresses the human tendency to have total control over the elements, a hopeless endeavour that already crumbles in front of technology from an ecological perspective. Being totality out of reach, a different relation must be built with increasingly intelligent





systems, as the movement of technology towards intelligence is inevitable.

As machines and robots are eroding the role of man out of labor, it is time to rethink the role of humans, not by trying to contain an inevitable tide, but learning how to ride it and redefine the role of humans. Antoine Picon advocates for a Ruskinian perspective on Robots: instead of trying to contain robots at all costs to preserve some jobs or activities, we should let them do what they can do better than humans and instead find a way to take advantage of the freedom that we can gain from that. "Nothing is to be gained in treating intelligent creatures as tools".[33]

The process of design should become more and more a conversation with ever increasing intelligent entities and acknowledge the existing symbiotic relation, rather than advocating a return to obsolete paradigms of subordinated tools and techniques alone. A rejection of technology is a puerile and dangerous stance, first and foremost because it is impossible to remove oneself from it, it is not a choice up only to the pure will of the single individual.

AVOIDING THE PANOPTICON

Technology should not be fetishised nor glorified, but taken as an inevitability, like life, like gravity. So does the fact that we are part of a larger ecosystem that can easily do away without us. But we should not be defensive about it, relegating technology once again as a passive element that we can mold at will and let it just do our bidding. This passivation attitude at once underestimates technology's transformative power, provokes a suspension of disbelief towards its outputs, and gives it unbridled freedom to operate in self-reinforcement (fueling extrapolative logic). Considering the activity of design, the result of the aforementioned trends is an analysis-derivative attitude: a fully precautionary scenario in which analysis (which becomes more and more technology intensive) is considered exhaustive and the project basically rearranges the pieces on this hypothetically constructed board with the ambition to "solve problems". This scenario ignores the inherent bias and incompleteness of projects, designers, and technology, ending up in a self-reinforcing cycle, validating at each step only what technology exposes and designers grasp. Everything eventually becomes analysis, scrutinization, control. The Panopticon, the famous proposal made by Jeremy Bentham for a prison, is an exemplar metaphor for

Figure 5: Mario Klingemann, 79530 Self Portraits, still (2018). Image ©Mario Klingemann and Nature Morte, New Delhi.
Figure 6: Elevation, section and plan of Jeremy Bentham's Panopticon penitentiary, drawn by Willey Reveley (1791).

this will of absolute control (Fig. 6). It is not technology in itself that leads to the Panopticon though, rather its constant underwhelming to an external, passive accessory in order to preserve the old paradigm of creativity as an exclusive product of human intuition (a form of vitalism, essentially considering ideas as being generated and fully formed inside the mind) imposed through an indifferent, dry apparatus. This kind of fake hylomorphism is the vessel for the validation of outdated paradigms, such as the reduction of computation to "modeling aid" or the use of the prefix "parametric" to substantiate a conventional process with few added features as a presumed novelty. It is a way of straightjacketing computation into something petty and harmless to preserve the traditional anthropocentric approach, a desperate attempt at resisting the most radical change: one that redefines human nature.

In this regard, a clarifying perspective comes from Neil Leach quote of Jonathan Hale in his comparison on how Heidegger and Merleau-Ponty consider tools and their interaction with human nature (with the latter being the most interesting one for our case): Heidegger sees tools and humans as interacting yet independent entities, whereas in Merleau-Ponty tools work by incorporation, restructuring and boundary redefinition - becoming incorporated (literally) into an extended *body-schema*, as a kind of prosthetic bodily extension that allows one to experience the world through it. [34]

Ignoring, resisting or refusing this transfigurative power of technology only leads to renouncing awareness, and with it a degree of control, on the consequences of an inevitable process, thus creating invisible harnesses.

In other words, this means giving up understanding and control only to be obsessed by control in another form: to keep in check the aftermath of the very things whose acknowledgement was renounced in the first place.

The more humans resist this reality, the more harnesses are created in order to preserve the old paradigm, and these harnesses by their very nature become in time instruments of control, forming a Panopticon - albeit not a Focaultian one, but a concealed one that nests within and emerges from this model, not explicit in its extensive limits. An example of such intensive and nested control is the way stores are tracking clients' motion patterns using cameras with computer vision to optimise product placement and paths. [35] These considerations do not regard just the loss of creative control in itself, but what architecture becomes when it renounces unbiased and unbridled novelty and creation (or, in other words, open-endedness, vagueness and indetermination): a pure instrument of control. The unchecked spread of poor design under the catalysing effect of industrial production and the philosophy of positivistic determinism has produced instruments of control of everyday's life in the form of serial housings and zoned neighborhoods, and one size fits all (so eventually all became one size) logic. Statistical instruments and techniques (such as big data, machine learning, etc.) are based on analysis; what is all too often unseen is that analysis are always partial by their very nature, they give a partial description of reality. In the absence of proposals of strategic, speculative nature, the sheer dependence from a specific model of rationality will produce only another Panopticon, an architecture for control and the preservation of the status quo, ruling out the unknown and all of its potential.

Note
Footnotes

1 FRIEDER NAKE, *Art in the Time of the Artificial*, Leonardo, Vol. 31, No. 3 (1998), pp. 163-164

2 MARIO CARPO, *The Alphabet and the Algorithm* (Cambridge: The MIT Press, 2011).

3 See: FRIEDRICH KITTLER, *Optical Media* (Cambridge; Malden: Polity, 2009).

4 See: URSULA K. LE GUIN, *The Left Hand of Darkness* (London: Hachette UK, 2018).

5 FRANK LLOYD WRIGHT, *Frank Lloyd Wright: An Autobiography* (San Francisco: Pomegranate, 2005).

6 FRANK LLOYD WRIGHT, "In the cause of architecture I – The Architect and The Machine." The Architectural Record, no. 61 (May 1927); 394.

7 See: MCKENZIE WARK., *Molecular Red: Theory for the Anthropocene* (London–New York: Verso, 2016).

8 ZACH MORTICE, "Frank Lloyd Wright Was a Proto-Algorithmic Architect," Metropolis, last modified October 6, 2017.

9 See: LUCIANA PARISI, *Contagious Architecture: Computation, Aesthetics, and Space* (Cambridge: The MIT Press, 2013).

10 JOHN HOLLAND, *Emergence* (Oxford: Oxford University Press, 1988), 13.

11 SOL LEWITT, "Paragraphs on Conceptual Art," Artforum 5, no. 10 (Summer 1967): 80.

12 CASEY REAS, "Process Compendium (Introduction)," video uploaded on April 27, 2011, 3:45, http://vimeo.com/22955812

13 LARS SPUYBROEK, "The Matter of Ornament," in The Politics of the Impure, edited by Joke Brower (Rotterdam: V2_Publishing, 2010), 242.

14 MATIAS DEL CAMPO, WeChat conversation with author, November 18, 2018.

15 Wark, Molecular Red, 164.

16 RICHARD SERRA, "Richard Serra: Tools & Strategies | Art21 'Extended Play'," video published on January 11, 2013, 2:47, https://www.youtube.com/watch?v=G-mBR26bAzA

17 STEVEN SHAVIRO, "Twenty-two Theses on Nature." last modified September 2, 2014, http://www.shaviro.com/Blog/?p=1253

18 See: KEVIN KELLY, *What Technology Wants* (New York: Viking, 2010).

19 LEVI BRYANT, "Machine-Oriented Architecture: Experiments in Absolute Architecture," last modified March 11, 2015.

20 As quoted by: PHILLIPPE MOREL, "'The minute you start encoding things you put intentionality into things' JOHN FRAZER," Facebook, June 16, 2018

21 See: ROLAND SNOOKS, "Volatile Formation." Log 25 (2012).

22 JEAN BAUDRILLARD, *Simulacra and Simulation* (Ann Arbor: University of Michigan Press, 1994).

23 STEVEN SHAVIRO, "Against Self-Organization," last modified May 26, 2009

24 See: MANUEL DELANDA, *Assemblage Theory* (Edinburgh: Edinburgh University Press, 2016).

25 ALESSIO ERIOLI, "Anexact Paths: Computation, Continuity, and Tectonics in the Design Process," in *Handbook of Research on Form and Morphogenesis in Modern Architectural Contexts*, edited by DOMENICO D'UVA (Pennsylvania: IGI Global, 2018), 1–19.

26 *Spuybroek. The Architecture of Continuity* (Rotterdam: V2_Publishing, 2008).

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28 ARNAV ADHIKARI, "AI art is on the rise – but how do we measure its success?," Apollo, last modified September 13, 2018, https://www.apollo-magazine.com/ai-art-artificial-intelligence/

29 "GradientDescent," *Nature Morte, accessed* February 28, 2019, http://naturemorte.com/exhibitions/gradient-descent/.

30 PASCAL CHABOT, *ChatBot le robot: Drame philosophique en quatre questions et cinq actes* (Paris: Presses Universitaires de France – PUF, 2016).

31 ANTOINE PICON, "Free The Robots," Log 36 (2016): 150.

32 NEIL LEACH, "Digital Tool Thinking: Object-Oriented Ontology versus New Materialism," in ACADIA // 2016: POSTHUMAN FRONTIERS: Data, Designers, and Cognitive Machines [Proceedings of the 36th Annual Conference of the Association for Computer Aided Design in Architecture (ACADIA)] (Ann Arbor, 27-29 October, 2016), 344-51.

33 SEAN SMITH, "easily visible dome surveillance cameras at IKEA North York as of november 19, 2018," Facebook, November 19, 2018.

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