Paola Sturla und Michael Jakob

Artificial Intelligence as (Meta-)Art? Emergent Technologies in the Design Process

Introduction

Over the past decades, the availability of environmental and behavioral data, together with the augmented computational capability of commercial workstations, have resulted in the popularity of automated data analysis tools, commonly referred to as "artificial intelligence" (AI). The easiness of implementation of data science techniques for generative pattern recognition suggests a potential integration with parametric Building Information Modelling (BIM) systems and Geographic Information System (GIS), highlighting the need for initiating a discussion on the impact of such media on design processes.

Albeit having gained public attention recently, research in the field of artificial intelligence has been developing since World War II when Warren McCulloch and Walter Pitts defined the artificial neural network (1943), Alan Turing worked on "Computing machines and intelligence" (1950), and machine learning[1] was invented to apply technologies developed for military purposes to civil activities, for example, the automation of repetitive administrative tasks. Later, the debate developed in an interdisciplinary way, starting with the "Artificial Intelligence" workshop at Dartmouth College in 1956, where scholars from the fields of mathematics, computer science, economics, and anthropology further explored the topic. Since the 1950s, research on artificial intelligence went through different phases of enthusiasm and skepticism because of both the difficulty in computing nuanced phenomena and the epistemological problems posed by statistical analysis. Over the past decades, philosophy-of-science scholars have been questioning the epistemology of automated data analysis. Coming to the field of artificial intelligence application in the design process, the debate has been less intense and articulate. The interest in developing a disciplinary discussion refers to the proactive quality of design, which aims at introducing artifacts into the physical world through the act of shaping, including a process of context interpretation. In order to contribute to this conversation, we are presenting our article from

1 Samuel 1959.

the designer perspective. The designer is someone who, in general, does not have philosophical training but aims to question the tools that are at the heart of the design process. To do so, let us clarify what a designer does. Following Lidia Gasperoni's article on design as a "humanistic practice"[2] let us borrow Umberto Eco's definition of the architect (or the designer at large) as the "last humanist"[3], that is as someone obliged to think comprehensively to deliver a physical object whose primary scope is not the mere use, but a form of contemplation by establishing relationships between systems on which she/he has no power. In other words, the designer is someone who holistically and critically operates in the world, interpreting the environmental, cultural, and spatial context, and addresses its ambiguity through the means of design. This concept implies that the action of interpretation is critical in the work of the designer.

2 Gasperoni 2019.

3 Eco 1968: 245.

By acknowledging that the environment and its interpretation are inextricably bound to the design process, and by questioning the epistemology of automated analytics, our paper provocatively asks if artificial intelligence is an aesthetic device producing outcomes that are a form of (meta-)art. By outcomes of an AI, we think of the product the algorithm generates. This could span from the revealing of patterns and complex relationships within the dataset and their visualization to a catalog of new forms in the field of generative design and a further evolution of parametric design. In the context of this article, we concentrate on the generative design side of the spectrum.

Our hypothesis is that the models for automated data analysis, because of their biases, do not satisfy the claim of objectivity often assumed when applying parametric design. However, as an aesthetic interpretation of a place, they inspire designers and stimulate their interpretation in the framework of the hermeneutic process of design. The aim is to contribute to a debate concerning the need for artificial intelligence in design practice with a focus on generative design.

Parametric Design, an Overview

During the second half of the twentieth century, in the field of architecture, practitioners and researchers got more and more interested in parametric design. Derived from analog parametric design, an established method in the field of civil engineering, its precedents can be traced back to Antoni Gaudi's structural models for the Church of the Colonia Güell (or *Sagrada Familia*) in Barcelona and to the theoretical and practical work of Italian architect Luigi Moretti[4]. At the same time, the need for controlling large scale territorial datasets to support ecological design in the field of landscape planning lead to the development of the layering of information method presented in "Design with Nature" by landscape architect Ian McHarg at the University of Pennsylvania[5].

4 Frazer 2016: 19.

5 McHarg 1969.

The parametric method has been converted into digital by Ivan Sutherland, a computer scientist who has foreseen the potentials for computation in the creative field. He programmed Sketchpad in 1963, initiating the debate on the human-computer-interaction in design[6]. Since then, research has unfolded thanks to the production of theoretical work on the notion of algorith-

6 Sears and Jacko 2007.

mic processes, for example in Ciro Najle's research at the Architectural Association and at Cornell University, the philosophical research of Mario Carpo [7], and experiments in practice led by a growing number of professionals like Frank Gehry, Zaha Hadid, UNStudio and more recently Groundlab. That experimentation has been fostered by a growing interest of software houses as Autodesk and McNeel in developing and selling commercial software for parametric computation in design. The interest in large scale datasets has led to the coeval development of McHarg's method into the Geographic Information System (GIS) by the Environmental Systems Research Institute (ESRI), a research center and a software house that was founded by one of his students.

This short history of computation in design reminds us of the entanglement between theory, practice, and commercial technological enhancement that shaped the parametric design approach. The notion of artificial intelligence is engaging within this cultural evolutionary framework because it implies the possibility of automating the process, or part of it, obtaining what we now call generative design. For this brief essay, let's define artificial intelligence as the study of "intelligent agents," technologies that can sense the environment and take action to achieve a goal [8]. Such technologies retain an ability to "learn" through statistical pattern recognition methods (data analysis) on "complex datasets" [9], commonly referred to as Big Data [10]. Big Data is produced as a result of the process of sensing the environment through manmade sensors, which are more and more automated and interconnected in their operations in the framework of the Internet of Things (IoT).

In recent years, the widespread interest in pervasive sensing and ubiquitous computing [11] has led to the emergence of the concept of generative design. For example, in their recent book *Codify* Bradley Cantrell and Adam Mekies published a series of essays related to the topic. The editors' approach implies a definition of design as a logical process based on generative and alterable computing abstraction. Given this premise, they underline the difference between computation and computing, the first being the mere translation of analog ideas into digital format for representation via commercial software, the second being the "systematic method for critical thinking that emphasizes through process and iteration over memorization and duplication" stressing the "linking of ideas" [12] via interfaces that bridge the lack of programming skills for designers. In order to support their hypothesis, the editors present a series of essays where generative design emerges as a topic, for example in the contribution by Jillian Walliss and Heike Rahmann "Computational design methodologies: an inquiry into the atmosphere," in which they explore the potential of computation, of "big and small data" [13], of simulations in addressing climate change, and where they define the designer as a curator who continually redefines the problem and the point of intervention as a consequence of knowledge provided by data analysis. *Codify* is just one example of the recent literature on the relationship between Big Data, artificial intelligence, and the production of space. This kind of research produced by practitioners in the field is relevant because it provides a disciplinary per-

7 Carpo 2011, 2017.

8 Nilsson 1998.

9 Vantini 2018.

10 Manyika 2011.

11 Weiser 1996.

12 Cantrell and Mekies 2018: 27.

13 Ibid.: 133.

spective on the problem. However, it commonly fails to take into account the broader debate on the agency of technology in shaping the way we operate.

Philosophers in the field of epistemology investigated the problem of the impact of technology on the scientific method. In June 2008, journalist Chris Anderson published on *Wired* "The End of Theory: The Data Deluge Makes the Scientific Method Obsolete"[14], arguing that the mass of data revealed by sensing technologies and ubiquitous computing devices would have made theory obsolete because scientific inquiry would turn into a data-driven, inductive bottom-up endeavor. Inductive, "intelligent" algorithms would reveal patterns and, therefore, in his opinion, knowledge without the need for formulating a research question. This provocative statement generated a reaction in the community of epistemologists. Although related to the scientific method, which does not require a design output explicitly, let us explore these arguments to provide a framework for investigating the role of artificial intelligence in design.

14 Anderson 2008.

Epistemology of Big Data

In his essay "Could Big Data be the end of theory in science?" (2015) Fulvio Mazzocchi reconnects the inductive method with the writings of Francis Bacon, who in 1620 defined the scientific method as based on experimental data rather than preconceived notions[15]. According to Mazzocchi, what is called Big Data science "renews the primacy of inductive reasoning in the form of technology-based empiricism and has inspired a view of the future in which automated data mining will lead directly to new discoveries."[16]

15 Bacon 1889.

16 Mazzocchi 2015: 1250.

Mazzocchi refers to the work of Viktor Mayer-Schönberger and Kenneth Cukier to enumerate three main innovations related to Big Data use: inclusiveness of analysis, less interest in precision, and emphasis on correlations[17]. The recent literature on the topic is vast[18]. This position has been supported and fostered by the fast technological development of the "info-sphere"[19] and its related business opportunities, concentrations of power, and mythology[20]. The result is a "rhetoric of objectivity" that has been influencing the public debate, and that often fascinates policymakers[21].

17 Mayer-Schönberger and Cukier 2013.

18 See also Kitchin 2014a, 2014c, 2014b; Kitchin and Dodge 2011.

19 Floridi 2011.

20 Crawford, Miltner, and Gray 2014.

21 Ebd.

The critique of this approach begins with the notion of data as a human construct: data are biased because of the purposes of their collection, and the instruments used to collect them. According to Martin Frické,

> "Data is anything recordable in a relational database in a semantically and pragmatically sound base. The semantics require for the recordings to be understood as true or false statements. The pragmatics suggest that we favor recording what seems to be concrete facts. Therefore, Data is conjectural." (Frické 2015: 652)

Moreover, every dataset (not necessarily a "big" one) is conjectural; therefore, data and Big Data are similar[22]. The public debate does not acknowledge this similarity. According to Lisa Portmess and Sara Tower, the metaphor that describes Big Data as a resource ("the new oil," "mining information") is mis-

22 Lipworth / Mason / Kerridge 2017.

leading and contributes to hide the ethical and epistemological problems related to their use [23]. This consideration recalls Bruno Latour's story of the expedition to the Amazon with a team of botanists and pedologists (Latour 1999) and their use of the "pedocomparator" to classify soil colors and textures and translate them into data. This kind of instrument supports a quick move from the physical to abstraction, attempting to minimize, but not to overcome the risk of relativism: "But won't relativism rear its monstrous head as we attempt to qualify the nuances of brown?"[24]

23 Portmess / Tower 2015: 3.

24 Latour 1999: 58.

The researcher's perception of the nuances of brown biases the data output of the pedocomparator, which is therefore conjectural, showing that there is a sort of implicit "art of data gathering"[25]. The data generated by the comparison of soil samples in the pedocomparator are mediated by the interpretation of the human researcher who abstracts them. Latour's argument demonstrates that intuition and interpretation are at the core of the scientific process of knowledge production, making it a cultural process.

25 Portmess / Tower 2015: 5.

When we deal with sensors-generated data, we are facing the same epistemological problem: their biases related to the instrument (the device design, its position, its capacity, etc.) that abstract them for us. Such biased conjectural data constitutes the training set for inductive "intelligent" algorithms that reveal patterns within them, allowing for automated inferential interpretations of the phenomena based on correlations. Following Frické's argument, this poses the problem of multiplicities (multiple connections) and their challenge to statistical conclusions.

To summarize, nowadays philosophy-of-science researchers and epistemologists are challenging the idea that automated analysis of "complex" datasets reveals a sort of embedded knowledge, rendering as problematic the notion of objective AI outcomes. On the contrary, the reference to the "art of data gathering" suggests that AI outcomes embed interpretations and are therefore conjectural. From a designer's perspective, this means that every attempt to design in a scientific and objective way through data-driven generative tools is illogical, and therefore the designer retains an agency in the process. Now the question becomes what are such technologies for in the design process?

The Designer as the "Last Humanist" and Luciano Floridi's "Logic of Design"

As mentioned in our introduction, we refer ourselves to Umberto Eco's definition of the architect (the designer) as the "last humanist":

> "The architect finds himself condemned, by the nature of his practice, to be the only and last humanist of contemporary society: obliged to think the totality precisely to the extent that he becomes a sectorial, specialized technician, intended for specific operations and not for metaphysical statements." (Eco 1968: 245. Translation by Paola Sturla)
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The architect as the "last humanist" is a generalist who interprets the context in which he is operating in a multidisciplinary way, understanding not only building techniques and materials, but also sociology, economics, ecology, and all the codified sectorial fields which contribute to the description and best possible knowledge of the complexity of the world.

Lidia Gasperoni highlights the dual code that characterizes architecture in Eco's theory, with an internal perspective (the perspective of architecture in itself), on the one hand, and an external one (architecture in relationship to complex systems, or "context" in order to use architectural jargon), on the other hand. Gasperoni refers to Kant and to the sensible qualities of the object, that make the object itself a part of the context[26]. The context influences, in other words, the design product, with the design output as a part of the context. Hence, architecture becomes "environment"[27]. As a consequence, considering architecture as environment helps understand the "productive skepticism"[28] it generates: being a complex object, architecture as environment resists understanding following clear, quantitative, and measurable standards. Architecture as environment allows, on the contrary, for manifold interpretations. Architecture and design are therefore based on aesthetic, interpretative, creative practices, rather than only on analytical ones. Because of the interpretative practice of design, the designed artifact does not provide a record for objectively describing cultural, economic, environmental dynamics, but is instead a synthesis which aims at making productive skepticism rather than knowledge. We want to stress here that the design process implies an aesthetic practice of context interpretation.

The notion of the designer as the "last humanist" suggests that the design process differs from scientific inquiry because it aims to interpret and synthesize rather than to understand. Luciano Floridi further investigated this concept in his last work, *The Logic of Information: A Theory of Philosophy as Conceptual Design*, defining design as "the blueprint that provides information about the system to be created."[29]

According to Floridi, the "logic of design"[30] differs from the two main models of the logic of knowledge production we inherited from modernity, namely "Kant's transcendental logic of conditions of possibility of a system, and Hegel's dialectical logic of conditions of in/stability of a system"[31], because of its poietic nature. Floridi calls a "system" the product of design (the building, the landscape, the chair), and the model of such system the blueprint which contains the information to create the artifact, in design terms: the project. Floridi defines design as an "independent epistemic praxis" based on functional and nonfunctional requirement settings. Following him, in the "logic of design", to understand is to construct. This point helps us grasp the role of the humanistic designer, who understands the system by building it. This recursive process of understanding is inferential: the relationship between what suffices the requirements and the implementation is not deductive, so the inference is neither inductive or adductive, but rather conductive. The requirement sets are based both on analysis and choice, and choice

26 Gasperoni 2019.

27 Uexküll 1926.

28 Gasperoni 2019: 306.

29 Floridi 2019: 188.

30 Ibid.

31 Ibid:1–20.

is pragmatic and not determinate, but rooted in a variety of circumstances, from social to accidental ones. After setting the requirements, the designer decides how to implement the preferred choice. As a consequence, given a set of requirements, multiple systems fit all of them, and the selection of implementing one or the other is the designer's decision. The decision process explains why "design is not an empirical kind of experimenting, but [...] a praxis"[32]. His argument is compelling and resonates deeply with the everyday experience of designers working at every scale, as the word blueprint does.

32 Floridi 2019: 193.

Moreover, Floridi states that implementing a "logic of design" in philosophy is essential because the "digital is transforming the nature of our concepts," especially concerning "weak", open, unstructured problems that allow for a variety of solutions. We want to slightly push Floridi's argument here by making explicit that design requirements do not include only mere functional ones. Designers work on the perception of their projects, on the experience they generate, on their modes of use, on their ecological relationships with the environment, in one word: they take into consideration the aesthetics of their artifacts.

To tackle this openness through an aesthetic practice of context interpretation requires a clear understanding of how we design solutions as "humanistic designers." From a designer's perspective, it is useful to reinforce this argument while investigating the potential role of artificial intelligence in practice.

Artificial Intelligence in the Humanistic Design Process

In the previous paragraphs we made two points: i) Big Data used to train artificial intelligence algorithms to reveal patterns and make statistical inferences are conjectural and biased by the context in which they have been gathered, by the instruments used to produce them, and by the human intention behind their collection. For this reason, their use in science poses epistemological issues. ii) The designer is the "last humanist" because he applies the "logic of design" to investigate a system by making the blueprint that contains the information to build it. This process of blueprint making implies an aesthetic practice of selecting functional and nonfunctional requirements based on circumstantial choices; therefore, a variety of systems implies a series of requirements.

Given these two premises, the application of generative design tools based on automated data analysis to generate new forms poses at least three questions:

1. The question of the blueprint: How can the humanistic designer produce a blueprint for a new system tackling a set of requirements if it is supported by an artificial intelligence trained on a dataset related to a blueprint for another, different system?
2. The question of context: How can an artificial intelligence trained on datasets gathered in another place and time generate an output applicable to a different, complex context?

3. The question of multiplicity: Having acknowledged that the designer as a humanist operates circumstantial choices to sort through multiple options, and each design is biased by the designer's point of view, how is the epistemological critique to artificial intelligence relevant in the context of the "logic of design"?

It seems that, given the biased nature of design, the conjectural artificial intelligence output could be part of the design process, which aims to produce an understanding of the system by constructing it. Therefore, the problem would instead be embedded at a deeper level in the way current artificial intelligence actually works: By being trained on datasets gathered in other places and times, generative design tools could miss the specificity and nuances of the phenomena characterizing the context where the next system will be developed, therefore misleading the production of its blueprint, or project.

Artificial Intelligence as (Meta-)Art?

Hence the question: Is artificial intelligence ultimately an aesthetic device producing a form of (Meta-)Art? Something that provides a conjectural, and always questionable contribution to the cultural process of design, as other media designers use to interpret the context do?

The notion of artificial intelligence as an aesthetic device that produces some kind of art is not a new one. The literature in the field of computational creativity is rich in experiments that attempt to make a computer-generated art. Computational creativity researchers ask if computers could produce creative content through massive, automated pattern recognition on existing art and design works[33]. Companies as Facebook AI experiment on automatically generated fashion recommendations[34] and on machines that learn like people[35]. The output could be potentially rendered via immersive experience technologies, Virtual Reality, and Mixed Reality. At the same time, neuro-aesthetics researchers investigate the impact of designed spaces and the environment on human perception and emotion, through experiments on behavioral data analysis as the one run by Google Design Studio during the 2019 Milano Design Week[36].

These contributions (and many similar ones which we are not referring to for the sake of synthesis) are relevant for the questions they raise. However, they all seem to imply that artificial intelligence generates the final artistic output. In our perspective, it appears more appropriate to investigate further whether artificial intelligence is relevant in the context of the hermeneutic design process. The outcome of a generative artificial intelligence becomes (Meta-)Art when it contributes to a process of cultural production, in a feedback loop with the designer, and with society at large. In other words, designers lead an interdisciplinary endeavor to navigate complex, open-ended problems through the logic of design to make (shape) objects that become themselves the context impacting the next round of the process. The AI outcome could provide additional aesthetic *stimula* to the loop, contributing to the result of the cultural process of design.

33 See, for example, Elgammal et al. 2017.

34 Wei-Lin et al. 2019.

35 Lake et al. 2017.

36 Ross 2019.

Another critical point is the notion of multiplicity. Floridi mentions circumstantial choices, and we could translate this idea by arguing that designers generally select among multiple potential correlations and that they do so using the information generated by the design process itself. That is where we could go with Bruno Munari in saying that the designer has an aesthetic sense[37], and with Cristopher Alexander who states that “there is no legitimate sense in which deductive logic can prescribe physical form for us.”[38]

37 Munari 1966.

38 Alexander 1967: 8.

The ability to sort through multiple valid options based on a recursive process is the peculiarity of design. Designers indeed understood this intuitively long time ago, but only a few of them were able to conceptualize their methodology. Lawrence Halprin defined the cognitive feedback loop between the community and his process as the “RSVP cycle”[39], acknowledging the non-linearity of a process that involves Resources, Scores, Valuation, and Performance (fig. 1). Halprin’s work contributed to theorize and visualize the creative process feedback loop between the environment, the context, and individual points of view on it. Halprin acknowledges that the design process is recursive[40], and therefore we could imagine artificial intelligence in a feedback loop[41] with the human designer. Being a statistical tool, artificial intelligence could contribute to enriching the information available to the designer to make choices. Instead of a linear implementation of artificial intelligence into the design process, something that the data-driven design literature frequently seems to suggest (fig. 2), we propose a recursive relationship based on the AI designer feedback loop (fig. 3).

39 Halprin 1969.

40 Munari 2009, 1977, 1966; Floridi 2019; Schön 1983.

41 Wiener 1948.

A Renewed “New-Humanism”

Beyond the discussion on the feedback loop itself, we think that the introduction of artificial intelligence in design constitutes an occasion for discussing a form of “new-humanism.” By “new-humanism,” we refer to the work of George Sarton, the founder of history of science as a discipline. In 1924, Sarton introduced an idea of “new-humanism” based on three pillars:

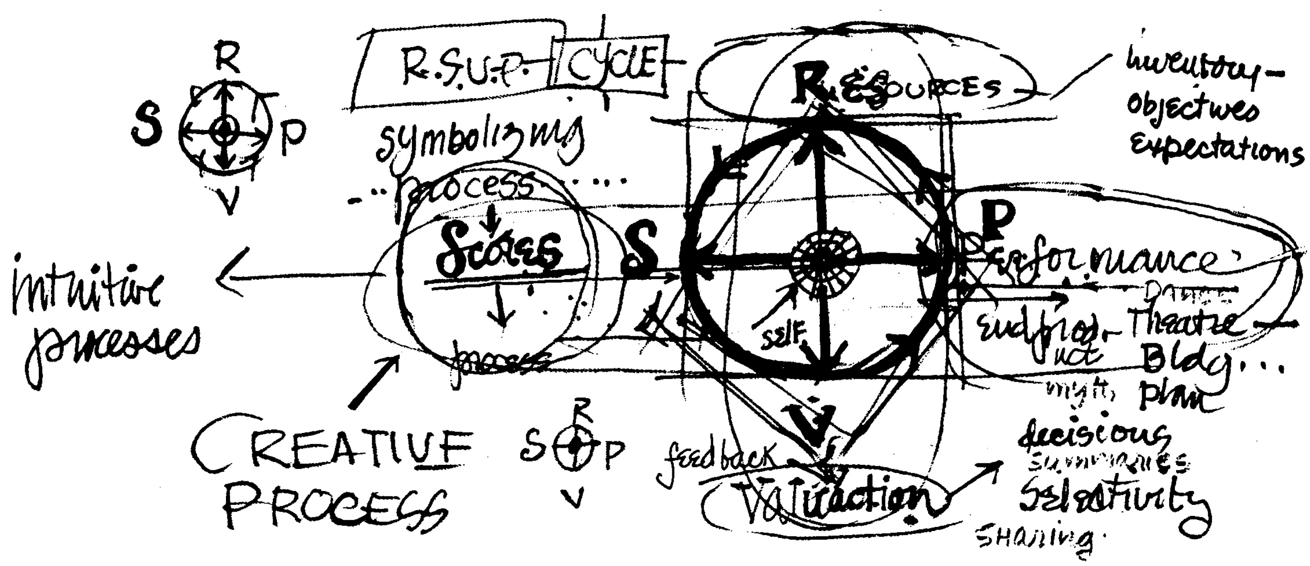

Fig. 1 Lawrence Halprin, the RSVP Cycle in: Chang, Ching-Yu. 1978. “Workshop: Take Part Process to Collective Creativity.” Process, Architecture, no. 4: 33.

> "Human progress is essentially a function of the advance of positive knowledge [...] The progress of each branch of science is a function of the progress of the other branches (principle of unity of knowledge) [...] The progress of science [is due to] the combined efforts of all people (principle of unity of mankind)." (Sarton 1924: 9–11)

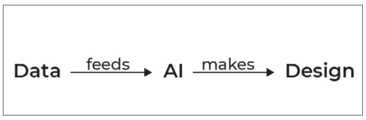

Fig. 2 Sturla, Paola. Elaboration on a linear design process

According to Sarton, "new-humanism" implies a "humanization of science"[42] through interdisciplinary work that brings together scientists, sociologists, philosophers, and so on. In the following paragraph, which sounds a little cynical, Sarton points to the reason why such a theory was needed in the "intellectual laziness of most men, the ignorance and pedantism of educators"[43]. In his opinion, the lack of interdisciplinary references could end up in a sort of "scientific Pharisaism, a worthless and stupid idolatry of facts, a system of meaningless conventions and unconscious prejudices"[44].

42 Sarton 1924: 32.

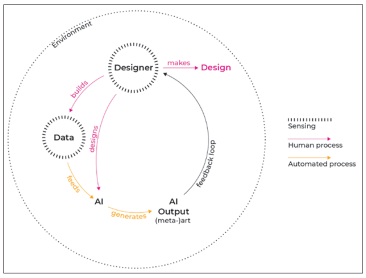

Fig. 3 Sturla, Paola. The hermeneutic design cycle

For this reason, one century after Sarton's text, the fact that artificial intelligence generates arrays of new forms through a data-driven approach presents similar problems. This is the reason for speaking about a renewed "new-humanism," which retains the original combination of "scientific and humanistic spirit"[45], but introduces a definition of knowledge adjusted to the recent advancements in the philosophy of science and in epistemology.

43 Ibid: 39.

44 Ibid.

45 Ibid: 32

Traditionally, humanism implied the idea of the superiority of the human over nature. This idea has been widely criticized over the past thirty years, leading to post-humanistic philosophy and design methodologies. Such design methodologies have suggested to avoid anthropocentrism by hiding the presence of the human in the process of design, pretending to obtain an objective description of the site through quantitative analysis rendered as maps, infographics, and metabolic diagrams. Such neutral analyses were expected to deliver "objective," "scientific" design through parametric techniques with a focus on non-human entities. This tendency explains the success of what has widely been called "data-driven design," and the notion of artificial intelligence as automated data analysis to obtain generative design tools seemed the most logical direction to take.

The epistemological debate on artificial intelligence sheds the light on the impossibility of transcending the point of view on the system that every human has, which is the result of cultural biases. Humans are entangled in the network of relationships between non-human entities, and they interpret such environment by experiencing it aesthetically: they sense it and make sense of it through their cultural biases. At the same time, datasets that describe the environment are conjectural and manmade, so they incorporate cultural biases as well, and so do manmade "intelligent" algorithms used to mine them. This contingency could be an occasion to redefine the "new-humanism" as an attitude that avoids anthropocentrism because it's non-hierarchical: such a neo-humanistic approach to design would consider the human as a part of the system, someone that observes the system from inside, someone who sits at the same hierarchical level of animals, machines, and all the non-human entities. This approach would avoid anthropocentrism by acknowledging that there is a multiplicity of points of view and consequent possible interpretations of a system. In synthesis, the renewed new humanistic approach would give back the creative agency to the designer, while avoiding the problem of anthropocentrism.

From a designer's perspective, such a statement resonates with the humanistic practice as defined by Eco and Gasperoni, suggesting than the "logic of design" and its synthetic comprehension of a system could be the field where such an interdisciplinary integration happens. This idea is supported by our experience in design practice, outside of the realm of academia, where such cross-pollination is a familiar baseline premise to the construction of artifacts of any kind.

Conclusions

In conclusion, artificial intelligence algorithm outcomes could be considered as (meta-)art when they are found within a process of cultural production. By recognizing that design aims at shaping the physical world and that the designer's point of view in itself biases the design process, we suggest that artificial intelligence could be engaged in a recursive feedback loop that expresses its aesthetic through its interface with the human practitioner. Such a feedback loop indicates the evolution of "new-humanism" toward a renewed "new-humanism," a rediscovery of the creative agency of the designer in an un-hierarchical relationship with nature.

Authors

Paola Sturla is a lecturer at the Harvard GSD in the Department of Landscape Architecture. Born and raised in Italy, she is a registered "architetto" and "paesaggista," researching on Artificial Intelligence in design practice. She has been practicing internationally in the field of infrastructure design. Paola holds a Master in Architecture (PoliMi, 2007), a Master in Landscape Architecture (Harvard GSD, 2011), and is a Ph.D. candidate in Urban Planning at Politecnico di Milano.

Michael Jakob teaches History and Theory of Landscape at hepia, Geneva, and aesthetics of design at HEAD, Geneva. He is a visiting professor at Politecnico di Milano and at the Accademia di Architettura in Mendrisio. His teaching and research focus on landscape theory, aesthetics, the history of vertigo, contemporary theories of perception and the poetics of architecture.

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Figures

Fig. 1 Lawrence Halprin
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