The Datafication of the Worldview

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Abstract

The goal of this article is twofold. Firstly, it aims at sketching the outlines of material hermeneutics as a three-level analysis of technological artefacts. In the first section, we introduce Erwin Panofsky's three levels of interpretation of an artwork, and we propose to import this approach in the field of philosophy of technology. Secondly, the rest of the article focuses on the third level, with a specific attention towards Big Data and algorithms of artificial intelligence. The thesis is that these new technologies are not only radically transforming our interactions with the world, or our modes of production and consumption, but also our worldview. In the second section, we rely on Panofsky's *Gothic Architecture and Scholasticism* in order to describe the Scholastic "mental habit" or worldview and its principles. In the third section, we confront this worldview with the mechanistic and informationistic worldviews. Our contribution consists in arguing that (1) Despite the differences, the Scholastic, mechanistic, and informationistic worldviews are part of the same logical and causal order that dominated Western epistemology, and (2) Today we are facing the appearance of a new worldview that we call "data worldview". Examples from design, architecture, and visualization of knowledge will be set all along the article.

Keywords: data; worldview; technological imaginaries; material hermeneutics; second digital turn

1. Introduction

The goal of this article is twofold. Firstly, it aims at sketching the outlines of material hermeneutics as a three-level analysis of technological artefacts. In the first section, we introduce Erwin Panofsky's three levels of interpretation of an artwork, and we propose to import this approach in the field of Philosophy of Technology. In particular, we argue that "material hermeneutics" refers to (1) (An analysis of) the ways in which technologies mediate the human access to the world – in the triple sense of self-world, with-world, and surrounding world; (2) the social conditions of production and use of technology, and

(3) the ways technologies are embedded in a general culture, a worldview indeed, and how technologies, or at least some of them, contribute to frame such a worldview. These three levels must not be understood in opposition to each other, but rather in articulation, according to the model of the hermeneutic circle.

The remainder of the article focuses on the third level, with a specific attention towards digital techniques and technologies, in particular Big Data and algorithms of Artificial Intelligence. The thesis is that these new technologies are not only radically transforming our interactions with the world, or our modes of production and consumption, but also our worldview. In the second section, we rely on Panofsky's *Gothic Architecture and Scholasticism* in order to describe the Scholastic "mental habit" or worldview and its three principles: (1) Totality, (2) Arrangement according to a system of homologous parts and parts of parts, and (3) Distinctness and deductive cogency. In the third section, we confront this worldview with the mechanistic and informationistic worldviews as presented by Dijksterhuis (1961) and De Mul (1999), respectively. Our original contribution consists in arguing that (1) Despite the differences, the Scholastic, mechanistic, and informationistic worldviews are part of the same logical and causal order that dominated Western epistemology, and (2) Today we are facing the appearance of a new worldview that we call "data worldview". Examples from design, architecture, and visualization of knowledge, which are actualizations or materializations of specific worldviews, will be set all along the article. In the conclusion, we briefly present three postulates that might be seen at the basis of this new worldview: (1) Emergence, (2) Non-programmability, and (3) Control without knowledge.

2. The Three Levels of Material Hermeneutics

With the goal of distinguishing between iconography and iconology as two possible approaches to art history, Erwin Panofsky (1955) proposed a curious example: an acquaintance greeting him by lifting his hat.[1] According to him, there are three levels of interpretation of such an event:

(1) Firstly, there is a perceptual level, in which one identifies mere patterns of colors, lines, and forms. Interestingly enough, Panofsky (1955, 26) stresses that when one identifies the configuration as an object (the acquaintance), and the change of detail as an event (hat-lifting), "I have already overstepped the limits of purely formal perception and entered a first sphere of subject matter or meaning"; (2) Secondly, there is one's realization that the hat-lifting stands for greeting. In order to understand the meaning of

[1] Panofsky borrowed this example from Karl Mannheim and his "Interpretation of the *Weltanschauung*". See Hart (1993).

this action, “I must not only be familiar with the practical world of objects and events, but also with the more-than-practical world of customs and cultural traditions peculiar to a certain civilization” (1955, 27). Hat-lifting is indeed peculiar to the Western world and is a residue of Medieval chivalry. This second level is called secondary or conventional, and it is intelligible rather than sensible; (3) Thirdly, the action of the gentleman can reveal to an experienced observer “all that goes to make up its “personality’” (Ibid.). With the term “personality”, Panofsky wants to indicate the fact that the gentleman is a man of the twentieth century, his social and cultural background, the history of his life and his present milieu; but the term also refers, more broadly, to a general manner of viewing and reacting to the world. In the single action of a single person like the acquaintance lifting the hat, one can find the reflection of an entire worldview. Such third meaning is the intrinsic meaning or content; it is, Panofsky (1955, 28) says, essential, while (1) and (2) are phenomenal, and defines it as “a unifying principle which underlies and explains both the visible event and its intelligible significance, and which determines even the form in which the visible event takes shape”.

The art historian transposes this threefold distinction to the analysis of a work of art. Our hypothesis is that the three levels of interpretation presented by the German art historian correspond to the possible manners of understanding Philosophy of Technology as a material hermeneutics: (1) Firstly, the term “material hermeneutics” can refer to (an analysis of) the ways technologies mediate the human access to the world – in the triple sense of self-world, with-world, and surrounding world. In the words of Verbeek (2003, 93) reading Ihde’s *Expanding Hermeneutics*, “[h]uman interpretations of and ways of being involved with reality are mediated by technological artefacts”. Classic hermeneutics has been victim of what might be called an “idealism of matter”. Among the several mediators between humans and the world, hermeneutics has considered language alone. Moreover, the language classic hermeneutics deals with is idealized, spirit without matter – voice without vocal expression, text without text layout, and so on. Don Ihde, Peter-Paul Verbeek, and other postphenomenologists often used the expression “material hermeneutics” to indicate an empirical approach in Philosophy of Technology dealing with the interpretative effects of technology use.[2] Interestingly enough, this empirical approach is already expressional and widely concerned about meaning. In other words, it has already overstepped the limits of pure form and matter. Philip Brey (2010) famously distinguished between two empirical turns in

[2] It must be noticed that in the specific case of digital technologies, textual and object-oriented hermeneutics intersect each other. In “digital hermeneutics” (Romele 2020a) one deals with double entry signs, which are both readable and executable, representative and performative. I thank Luca Possati for this remark.

Philosophy of Technology, one engineering-oriented, and the other society-oriented. One might legitimately wonder if there is any analogy between this distinction and Panofsky's distinction between a factual and an expressional perspective at the level of the primary or natural subject matter.

(2) Secondly, "material hermeneutics" can refer to the social conditions of production and use of technology. Before Ihde and Verbeek, the expression "material hermeneutics" has been used by the Hungarian philologist Peter Szondi – see in particular Thouard (2013, 109-114). On the one hand, he wanted to stress, against the ontological turn of Gadamer's hermeneutics, the necessity of an object-oriented investigation of texts, conducted with the most rigorous philological resources. On the other hand, he also wanted to highlight the necessary critique of their social conditions of production and fruition, according to the definition of the term "material" has in the Frankfurt School for Social Research. In Philosophy of Technology, this approach would entail the realization that technologies are always more-than-empirical, because they are always embedded in normative and social conditions of possibility – on this point, see Romele (2020b).[3] In the specific context of postphenomenology, Robert Rosenberger's work on "callous objects" proceeds in this direction. According to Rosenberger 2017 (Chapter 4, "Politics"), "technologies should also be understood as essentially wrapped up within our society's larger politics, including economic systems, law enforcement procedures, democratic and undemocratic representational schemes, penal methods, and racial and sexual power dynamics, to name just a few of the basics".

(3) Thirdly, "material hermeneutics" can refer to the ways technologies are embedded in a general culture, a worldview indeed, and how at least some technologies contribute to framing such a worldview. In chapter 6 of Ihde (1990), significantly entitled "Cultural Hermeneutics", Don Ihde discusses the notion of "multistability", which refers to the fact that technologies essentially depend on their multiple uses, which in turn depend on different cultural contexts while framing it.[4] Ihde (1990, 125) offers, among several others, the example of the oval sardine cans left behind by the Australians after entering the New

[3] In this article, we make the example of the public transport systems in a metropolis. Transport systems are full of designs that allow specific uses and prohibit others, such as the anti-homeless benches. They also have several norms which cannot be directly embedded into the technological design, like the prohibition in many cities to perform music on buses and subways. But what is particularly interesting is that often social actors/group have a 'sense' of what is allowed and what is not. For instance, whilst all parts of Paris are well connected to each other by public transports, people from poorer arrondissements of the Rive Droite have perfectly internalized the fact of not going into the richer arrondissement of the Rive Gauche – and vice versa of course. This does not happen because they cannot, nor because they are not allowed to, but because they do not "authorize themselves" to do so.

[4] On the cultural dimension of material hermeneutics, see Tripathi (2017, 137), who defines technology as a "fundamental cultural force". The author opportunely stresses that postphenomenologists should give more importance to "cultural variability", and they should address the meaning of "socio-cultural activity" (Tripathi 2017, 140).

Guinean highlands for the first time, in the 1930s, in search of gold. These cans were immediately snatched by the New Guineans as treasured objects, and made into centerpieces of the elaborate headwear they wore for special occasions. While in this case a technology has been newly "absorbed" by the culture in which it found itself, things can go also the other way around: a technology can contribute to modifying an entire culture or worldview.[5]

This third level of the "intrinsic meaning or content" must not be seen in contradiction with (1) and (2), but rather in articulation with them. Ultimately, material hermeneutics of technology can be defined as a threefold process of analysis in which an artifact is studied (1) at the perceptual level of the technological mediations, (2) at the social level of its conditions of production and use, and (3) at the cultural level of the worldview in which it is embedded which thus often contributes to frame. While Panofsky suggests that the latter has an intrinsic superiority compared to the two previous ones, here it is argued that one should think of them in terms of symmetry or, even better, hermeneutic circularity.

The rest of this article focuses in particular on (3), since (1) and (2) have already been the object of other publications (Romele 2020a; 2020b). Specific attention will be paid to digital technologies such as Big Data and algorithms of Artificial Intelligence. The thesis is that these technologies are not only radically transforming our interactions with the world, or our modes of production and consumption, but also our worldview. We call this emerging worldview "data worldview". Jonathan Gray introduces the concept of "data world" as horizons of intelligibility. According to him, "just as industrial technologies of the past were accompanied by new social, cultural and political imaginaries, so we can trace the ascent of 'data imaginaries' and 'data speak': visions and rhetoric concerning the role of data in society" (Gray 2018, np).

3. Gothic Architecture, Scholasticism, and Trees of Knowledge

It is beyond the scope of this article to reconstruct the complex history of the concept of worldview. The use of the notion here is similar to Wittgenstein's reference to a "world picture" (*Weltbild*) as the ensemble of those certainties that are never directly interrogated or doubted, and represent the

[5] Ihde (1990, 126) makes the example of the Papua New Guinea people the Puluwateans: "The Puluwateans steered by wave patterns, without a compass. Once becoming acquainted with the compass, these navigators adopted its use – largely because the compass was at first an object of fascination rather than something useful. A compass conferred prestige. But once it had been adopted and used for of its purposes – to steer a straight course – it became possible to unlearn (de-skill) the more difficult wave perceptions, which were part of a complex initiation process in seamanship".

background of all our practical and epistemic attitudes towards the world. A world picture is culturally and socially transmitted. For instance, in the § 162 of *On Certainty* (1991), Wittgenstein says: "In general I take as true what is found in text-books, of geography for example. Why? I say: All these facts have been confirmed a hundred times over. But how do I know that? What is my evidence for it? I have a world-picture. Is it true or false? Above all it is the substratum of all my enquiring and asserting".

In this section, we are going to refer to Panofsky and one of his major works, *Gothic Architecture and Scholasticism*. Truthfully, Panofsky (1976, 54) does not resort to the term "worldview", but to "mental habit" or *habitus*. Moreover, he is less interested in defining this notion rather than describing the specific characters of the Scholastic *habitus*. He refers to Thomas Aquinas and the Scholastic tradition of the late twelfth and thirteenth centuries, which recovered the *Nicomachean Ethics* of Aristotle. *Habitus* is, indeed, the Latin translation of the Greek word *hexis*.[6]

In the *Nicomachean Ethics*, Aristotle affirms that virtue must not be confused with a single moral act or a series of acts. Being virtuous is not merely doing what is good, but doing so as a result of a well-formed moral character or set of moral habits. The stability of virtue is not the consequence of natural inheritance, but the result of a continuous activity regulated by moral education. Aquinas, in particular in the *quaestiones* 49–54 of the *Summa Theologiae*, refers to the *habitus* for the acquisition of Christian virtues as durable dispositions. The *habitus* is what distinguishes humans from both God, who is pure act, and animals, which cannot overcome their basic nature.

There is a fundamental difference between these classic uses of the term, and Panofsky's. In Aquinas as in Aristotle, the virtuous ones are those who cultivate a certain quality of the soul in order to act according to the Good. Alternatively, for Panofsky, there is no Good or Beautiful per se. It is rather a specific *habitus* which determines what humans, as members of a specific culture and society, consider as being good and beautiful. In other words, the *habitus* is the way a specific culture or society knows, acts, evaluates, appreciate, and discriminate among the things of the world. It is not by chance that the Greek term "*hexis*" has the verb "*echein*", "to have", as its root, which is also the etymological root of the term "*schema*". The *habitus* is a culturally and socially-determined schematization or categorization of the world.

[6] For an exhaustive history of the *habitus* in philosophy and social sciences, see Sparrow and Hutchinson (2014).

Panofsky's use of the concept of *habitus* is part of a general movement of socialization and historicization of the Kantian schematism, especially via Cassirer, and it is precisely for this reason that "*habitus*" can be used in this context as a synonym of worldview or world picture. This specific understanding of the *habitus* has been largely popularized by Bourdieu, who in 1967 translated it in French and wrote a long afterword to Panofsky's *Gothic Architecture and Scholasticism*. According to Bourdieu (2005, 226), the use of the term in Panofsky indicates that "the creator [i.e. the artist, the philosopher, and so on] partakes of his community and time, and guides and directs, unbeknownst to him, his apparently most creative unique acts".

The main difference between Bourdieu and Panofsky lies in the fact that the latter refers to the *habitus* as the expression of an entire culture, "a system of internalized schemes that have the capacity to generate all the thoughts, perceptions, and actions characteristic of a culture" (Bourdieu 2005, 233). Over the years, Bourdieu has instead socialized this perspective by fragmenting the *habitus* – a *habitus* is specific to each social class. Yet one could still argue that the general rules of distribution of the multiple *habitus* among the social classes or group still correspond to a unitary worldview. In other words, the *habitus* of a single social class or group depends on the public recognition and role which are attributed to this class or group within a specific culture or society.

As already said, Panofsky is less interested in defining what a *habitus* or worldview is, rather than describing the Scholastic *habitus* and worldview as such. Specifically, his hypothesis is that "in the period between about 1130-40 and about 1270, we can observe […] a connection between Gothic art and Scholasticism which is more concrete than a mere 'parallelism' and yet more general than those individual […] 'influences' which are inevitably exerted on painters, sculptors, or architects by erudite advisers" (Panofsky 1976, 20). In the same passage, he speaks of "cause-and-effect relation" which "comes about by diffusion rather than by direct impact" as it would be the case with individual influence. In other words, Panofsky contends that architects and philosophers of that time were embedded, and also contributed to framing, through their works, a specific worldview.

This worldview primarily consists of a renovated trust in human reason. Reason can furnish proof of whatever can be deduced from principles other than revelation. Moreover, it can elucidate the content of the revelation itself: argumentatively, it can refute all rational objections to the articles of faith (Trinity, Incarnation, and so on); it can also supply similitudes which manifest the mysteries by way of analogy (Panofsky 1976, 29-30). Panofsky defines *manifestatio*, "elucidation" or "clarification", the first controlling principle of Early and High Scholasticism. In order to elucidate faith by reason, such principle should be first applied to the reason itself, and this could be done, Panofsky (1976, 31) says, “only by a scheme of literary presentation that would elucidate the very processes of reasoning to the reader’s imagination just as reasoning was supposed to elucidate the very nature of faith to his intellect”. Hence the schematism of Scholastic writing based on three requirements or principles: (1) Totality – that is, sufficient enumeration; (2) Arrangement according to a system of homologous parts and parts of parts – that is, sufficient articulation; (3) Distinctness and deductive cogency – that is, sufficient interrelation. Today, we take for granted that academic works, especially in philosophy, are organized into schemes of division and subdivision, and summarized in a table of contents where all parts denoted by numbers or letters of the same class are on the same logical level. However, this structure was unknown before Scholasticism (Panofsky 1976, 32).

These same three requirements or principles can be found in Gothic architecture: (1) Firstly, totality, insofar as High Gothic cathedral “tended to approximate, by synthesis as well as elimination, one perfect and final solution” (Panofsky 1976, 44). The Gothic Cathedral sought to resume the whole Christian knowledge, with everything in its place and that which could not find its place, suppressed; (2) Secondly, the arrangement according to a system of homologous parts and parts of parts. In Gothic cathedrals, this principle is evident for instance in the uniform division and subdivision of the whole structure (Panofsky 1976, 45-49); (3) Finally, the theoretically unlimited fractionalization of the Gothic cathedral is domesticated by the third requirement or principle, that is distinctness and deductive cogency. While forming an indiscerptible whole, the Gothic elements must also remain clearly separated from each other, and yet there must be an unequivocal correlation between them. This is, for instance, the structure of the first part of Aquinas’ *Summa Theologiae*:

I. Essence (qu. 2-26);
- a. Whether God exists (qu. 2);
    1. Whether the proposition of His existence is evident (art. 1);
    2. Whether it is demonstrable (art. 2);
    3. Whether He does exist (art. 3);
- b. How He exists or, rather, does not exist (qu.3-13);
    1. How He is not (qu. 3-11);
    2. How He is known to us (qu. 12);
    3. How He is named (qu. 13);
- c. His operation (qu. 14-26);
    1. His knowledge (qu. 14-18);

2. His will (qu. 19-24);
3. His power (qu. 25-26);

II. Distinction of Persons (qu. 27-43);
a. Origin or procession (qu. 27);
b. Relations of origin (qu. 28);
c. The Persons as such (qu. 29-43);

III. Procession of creatures (qu.44-end);
a. Production of creatures (qu.44-46);
b. Distinction of creatures (qu. 47-102);
c. Government of creatures (qu. 103-end).

The Portal of Judgment, the central portal of the Western façade of Notre-Dame de Paris, installed in the years 1220-1230, is representative of the visual logic of Gothic architecture. Totality, division, and distinctiveness are evident, we believe, both in the *Summa*'s and in the Portal of Judgment.[7]

At this point it is worth mentioning that the Scholastic worldview does not only concern architecture and philosophical treaties. For instance, in his postface, Bourdieu refers to the work of the French paleographer and archivist Robert Marichal who establishes a set of analogies between Gothic handwriting, and Gothic architecture (Bourdieu 2005, 233).

Diagrams represent another privileged field in which the Scholastic worldview manifests itself. This is the case, in particular, of tree diagrams. Trees went visual long before Scholasticism, especially through Aristotle, Porphyry, and Boethius. However, while these authors set the foundation for such a visual and epistemological model, the most critical stage in the development of the tree metaphor took place during Scholasticism (Lima 2014, 23). Trees were more than visualizations allowing a representation of logical features like opposition, contradiction, coherence, coincidence, and derivation. They were also models and metaphors for representing the way in which the human mind and thinking work, and more broadly they were used to define humans as such – see, for example, the image of man (*homo*) as inverted tree (*arbor inversa*) in authors like Thomas of Cantipré, William of Conches, and Aquinas (Higuera 2019).

Visualizations like trees of knowledge are strictly related, then, to the ways in which human beings are understood and are able to understand themselves. Incidentally, this means that while "visual hermeneutics" (Ihde 1998; Heiwood and Sandywell 2005) has mainly dealt with the empirical – technical, perceptual, cognitive, and so on – implications of diagrams and other visualizing instruments,

[7] https://commons.wikimedia.org/wiki/File:Notre_Dame_de_Paris_main_gate.jpg. Accessed May 1, 2020.

according to the three levels of material hermeneutics proposed in this article it should also consider the social and cultural entanglements of these visualizations[8].

One of the most representative expressions of the use of trees for the visualization of knowledge is Ramon Lull's *Tree of Science* (*Arbor Scientiae*) which was written between 1295 and 1296. In this book, fourteen principal trees and two auxiliary trees are designed, each one devoted to a specific science – physics, ethics, anthropology, christology, et cetera. The roots represent the basic principles of each science; the trunk is the structure; the branches, the genres; the leaves, the species; and the fruits, the individual, with their acts and finalities.[9]

In Trees of Knowledge, the Scholastic worldview with its principles are beautifully summarized: (1) Totality, both in the sense that a whole science or object of knowledge is represented in a single image – and exceptions are excluded – and, at least in the case of Llull's work, all human knowledge is summed up in a defined series of visualized trees; (2) Arrangement according to a system of homologous parts and parts of parts, which is the very structure of a tree with symmetrical roots, trunk, branches, leaves and fruits, each of them determining a specific logical level; (3) Distinctness and deductive cogency, since elements in a tree are multiple but not infinite, and thus they are clearly distinguished from each other.

4. Mechanic, Informationistic, and Data Worldview

As strange as it might sound, technologies are always more than just artefacts. They are embedded in social and cultural conditions of possibility, and they contribute to frame them. This is particularly true, today, of digital technologies like Big Data and the algorithms of Artificial Intelligence. While certainly increasingly effective from a technical point of view, one might argue that their effectiveness also depends on the social and cultural atmosphere in which they are embedded. For instance, Taina Bucher (2017) introduced the notion of "algorithmic imaginary" which is not just productive with respect to different moods or sensations about algorithms – in the case of Bucher's article, Facebook's algorithm –

[8] Tripathi (2016) opportunely stresses that the objects of visual hermeneutics are neither texts nor linguistic phenomena, but things which come into vision through instrumental magnifications, allowing perception to go where it has not gone before. Ihde examines for instance a style of interpretation based in material practices relating to imaging technologies which have given rise to the visual hermeneutics in technoscience studies. We argue that such a visual hermeneutics should be expanded towards the impact of these visual representations on the social and cultural imaginaries of science and technology.

[9] See, for instance, the title page of a XVIth century manuscript of Llull's *Tree of Science*: http://www.historyofinformation.com/image.php?id=859. Accessed May 1, 2020.

but plays a generative role in moulding the algorithm itself. Similarly, we can say that nowadays the force of digital techniques and technologies like Big Data and the algorithms of Artificial Intelligence lies partly in the technologies as artefacts, but also in the fascination and trust we are increasingly well-disposed to give to them. The hypothesis of this third section is that today our worldview is shifting and everything – our bodies and minds, but also science, technology, and older imaginaries –[10] is about to be understood in terms of data. It is precisely this transformation that we call the "datafication of the worldview".[11]

Jos De Mul (1999) introduced the notion of "informationistic worldview" through a discussion of *The Mechanization of the Worldpicture* (1961), a book by the Dutch historian of science and technology Eduard Jan Dijksterhuis originally published in 1950. According to Dijksterhuis, the mechanization of physical science in the sixteenth and seventeenth century has become more than just a question of method in natural science; it has affected an entire culture. De Mul borrows this idea to understand the impact of information and communication technologies. Between the 1990s and 2000s, the notion of information was indeed applied to disciplines as different as computer science, physics, chemistry, biology, cognitive science, ethics, and ontology.

Two critical approaches towards such use of the notion of information are possible. The first consists of criticizing its genuine capacity to explain such numerous and different phenomena. Oppositely, the second consists of accepting that information is more than just a scientific or technical concept, and has entered into the domain of the social and cultural imaginary. This is the path De Mul takes in his article, identical to the one here. Big Data and algorithms of Artificial Intelligence have taken, we believe, the space occupied in the past by information, because data and algorithms, especially algorithms of machine learning, today seem capable of offering a solution for all sorts of epistemological, social, and ontological issues. Before such a situation, two attitudes are possible. The first one consists of criticizing their technical potential. However legitimate and necessary, this demythologization potentially lacks an important point, that is the fact that data and algorithms of machine learning nowadays have a prominent

[10] It would be interesting to investigate how the older imaginary of space exploration is currently revitalized through the new Big Data and Artificial Intelligence imaginary. Among the many non-academic articles available online, see https://www.forbes.com/sites/bernardmarr/2017/10/19/why-space-data-is-the-new-big-data/#7b0b381c69a1. Accessed 1 May 2020. On the consequences of "data centrism" in science, see Lionelli (2016). On the consequences of the understanding of the self, and one's own body, in terms of data, see Ruckenstein and Pantzar (2017).

[11] There is no room in this context to discuss the notions of information, data, algorithm, and eventually software. We content to say that data are "differences that make the difference", information is data + a meaningful structure, and what characterizes algorithms is recursivity, which is an elementary capacity of self-reference. I thank again Luca Possati for this remark.

role in our social and cultural imaginary. The second attitude consists precisely of accepting from this point forward, like it or not, a social and cultural fact that must be studied as such.

In the epilogue of his book, Dijksterhuis distinguishes several meanings of the "mechanization of the world picture", three of which are considered by De Mul: (1) The first consists of seeing the physical universe as a machine which, once it has been set in motion, by virtue of its construction performs the work for which it was called into existence; (2) The second is linked to the tendency of modern physics to search for hidden mechanisms behind those that can be perceived by the senses; (3) The third is related to the mathematical way of working of mechanics, not only in the sense that mechanics makes use of mathematical methods, but also in the stronger sense that mechanics itself *is* a mathematics (De Mul 1999, 76). These three meaning corresponds to the three postulates of the mechanistic worldview: (1) Postulate of analyzability, according to which reality can be analyzed as a collection of elements which are separate from each other, and which can be determined logically and independently from each other; (2) Postulate of lawfulness, according to which the atomic elements of reality are brought together by means of law that can be expressed in the form of mathematical equations; (3) Postulate of controllability, that allows prediction over events within a reasonable margin of success. These three postulates, De Mul (1999, 77) contends, have played an important role in the modern project of the "domestication of destiny".

For us, it is noteworthy that these postulates are the continuation of the three Scholastic principles with other – mathematical – means. The domestication of human destiny started when human beings found new trust in their reason – if they actually ever really lost it. Trees of knowledge, philosophical treaties, and Gothic cathedrals where first and foremost artefacts through which reality was rationally represented in the totality of its parts, these parts were analyzed in their logical interactions, and predictions about the possible events within this schematized reality were, certainly still rudimentarily, possible.

De Mul (1999, 84-88) distinguishes between three meanings of the informationistic worldview: (1) It suggests that the physical universe could be regarded as an information-processing machine. The idea according to which the human brain is a computer is a variant of this informationistic worldview; (2) It can refer to the tendency of Information Sciences to look for hidden algorithms behind what can be experienced through the senses; (3) It suggests that reality can be described in mathematical terms because it is ultimately written in a mathematical language – which is no longer just the language of mechanics, which describes the movement of bodies, but the language of information engineers and computer scientists. These three meanings corresponds, like in the case of the mechanistic worldview, to three postulates: (1) Postulate of synthesizability, according to which the informational sum is greater than its parts – the form of information at a lower level of abstraction is a matter for a higher level of abstraction; (2) Postulate of programmability, which means that the linking of the elements of reality is no longer made through laws, but by writing a computer program that simulates the object or event to be explained; (3) Postulate of manipulability, according to which when the laws of nature become the subject of manipulation, the path towards the programming of a new world is opened. In other terms, information sciences would be less concerned about what the world is than what it could be.

We contend that the informationistic worldview is still halfway between the mechanistic world picture and the data worldview that is going to be sketched out in this article. The data worldview is based on a sort of collapse of the logical and causal order that dominated Western epistemology. Despite some differences, such logical and causal order is the basis of the Scholastic, mechanistic, and informationistic worldviews.

In a 1983 article entitled "Antiporphyry" (2012), Umberto Eco had a vague intuition of this shift. The article is a rigorous deconstruction of the tree-model of knowledge, which is for Eco the basis of contemporary science. For him, this model cannot account for the infinity of possible features that characterize all entities and events of the world.

Eco opposes two epistemological models, the dictionary and the encyclopedia. He believes that the former, which implies the possibility of a complete and finite definition of each entity of the world is a theoretical idea which is materially unrealizable because every rigorous dictionary contains encyclopedic elements which undermine its supposed purity. From a historical perspective, the dictionary model is the result of an improper translation by Porphyry of the Aristotelian logic in terms of trees. Undoubtedly, the tree-model is tributary of a Neoplatonic conception of the chain of being, which brought Porphyry to believe in the possibility of having a finite tree that can represent and predict all forms of existing and not-yet existing beings along with their accidents. But Aristotle, who actually resorted to a tree-model for its logical writing, abandoned it when confronted with real beings, like in *De partibus animalium*. The dictionary is always a concealed encyclopedia.

According to the Italian semiotician, the labyrinth is the metaphysical model on which the encyclopedia is based. One can distinguish three kinds of labyrinths: (1) The classical "one-way" model: as one enters it, one cannot but reach the center – without the possibility of finding the way out; (2) The second is the mannerist labyrinth or *Irrweg*, which proposes different choices: all paths leading to a dead end, except for one; (3) The third is a net, in which every point might be connected with every other point. It is indeed this third model that resembles the encyclopedia. Eco (2012, 96) describes the net as follow:

It can be finite […] or infinite. In both cases, seeing that each point can be connected with every other point, and the connecting process is also a continual process of correction of the connections, it would always be unlimited, because its structure would always be different from what it was before […]. A network is a tree plus infinite corridors which connect the nodes of the tree.

He also refers to the nearsighted (also called "myopic") algorithms, in which the automaton only has the knowledge of its immediate neighborhood. But what is most interesting for our purposes is that he equally refers to Deleuze and Guattari's notion of rhizome. While he shares the enthusiasm of the two French authors for this model, in which every point can be connected with every other, he also notices: "It is said that in the rhizome there are no points or positions, but only lines, yet this characteristic is doubtful because every intersection of lines creates the possibility of localizing a point" (Eco 2012, 97). This remark is important because it suggests that whilst Deleuze is a thinker of lines – think of *The Fold* (1992) – Eco has at least a vague intuition of the relevance of dots. Whilst Deleuze is a philosopher of information, Eco is oriented towards data. However, this orientation in Eco is incomplete, because networks, that is, edges plus nodes, are still halfway between the two. Within the contemporary data worldview, we contend that lines are of decreasing importance.

In order to further develop this reflection, we refer to Mario Carpo's (2017) idea of "second digital turn". Carpo's approach is fascinating insofar as he looks for confirmations of his theory in architecture and design, an approach that somehow recalls that of Panofsky. The main difference between Panofsky and Carpo is that the latter focuses more on the use of some techniques and technologies in architecture. In this way, he eventually suggests a sort of causal relation between technological innovation, the appearance of new architectural styles, and the second digital turn. Instead, Panofsky remains on the level of analogies or "family resemblances".

According to the Italian architect, the essence of the second digital turn can be summarized in the motto "Search, Don't Sort". "**Search Don't Sort**. Use Google search to find the **exact message**" (bold in the original) was the tagline below the Gmail logo when the service was launched in 2004. Indeed, Gmail was the first email service to make the full text of all email messages, sent or received, searchable for words and numbers. According to Carpo (2017, chapter 2.2. "Don't Sort: Search"), this "Search Don't

Sort" attitude "suggests that automated full-text search for words or numbers on a whole corpus of sources, left raw and unsorted, is a more powerful retrieval tool than the traditional manual process of first sorting items by topic and then looking for them in their respective folders". In other words, given the data opulence we have begun to face a number of years ago, the best solution is to delegate to a machine, an algorithm, the task of finding a personalized, partial, and ephemeral path of order and meaning for us. Arborescent structures are made for human minds and memories. But computers work differently. For example, "[t]o search for the word "abacus" in a corpus of textual data, computers will scan the whole corpus looking for a given sequence of forty-eight 0s and 1s, and stop whenever that sequence shows up – regardless of how that corpus may or may not have been sorted. Computer search, they don't sort" (Ibid.).

This new perspective, Carpo argues, has become visible in contemporary design and architecture. For him, the spline-based curve (one of the novelties of early CAD/CAM) is somehow the best example of the "small-data logic" of the first digital style in the 1990s. It can be said that this style is somehow informational and, interestingly enough, Carpo does not neglect to notice the influence of Deleuze's fold in the development of this curvilinear style. Deleuze's fold is indeed a mathematical curve that he related to the continuous functions and to Leibniz's invention of the differential calculus. Similarly, spline modelers are instruments that can translate any random cluster of points into perfectly smooth and curving lines. Thus, a spline is the smoothest line joining a number of fixed points. Spline modelers have been imported, via the work of Pierre Bézier and Paul de Casteljau for Renault and Citroën, in architecture by Frank Ghery and his studio in Los Angeles. Works like Barcelona's Fish and Bilbao's Guggenheim museum are icons of the first digitally driven architectural style.

In recent years, the architecture of Zaha Hadid has brought this curvilinear, logarithmic, and possibly, informational style, to its highest expression. She fundamentally contributed to the constitution of a specific style called "parametricism", which relies on programs, algorithms, and computers to manipulate mathematical equations for design purposes.[12]

According to Carpo, this kind of "small data-oriented architecture" and design has already been overcome by the use of Big Data and algorithms of Artificial Intelligence to engage

[12] See Zaha Hadid's Heydar Aliyvev Center in Baku: https://commons.wikimedia.org/wiki/Category:Heydar_Aliyev_Cultural_Center#/media/File:Haydar_Aliyev_Culture_Center.jpg. Accessed May 1, 2020.

the messy discreteness of nature as it is, in its pristine, raw state – without the mediation or the shortcut of elegant, streamlined mathematical notations. The messy point-clouds and volumetric units of design and calculation that result from these processes are today increasingly shown in their apparently disjointed and fragmentary state; and the style resulting from this mode of composition is often called voxelization, or voxelation (Carpo 2017, chapter 2.7 "Excessive Resolution").

A voxel is a three-dimensional pixel. Among the several examples offered by Carpo, let us consider the Computational Chairs Design Studies by Philippe Morel of EZCT Architecture & Design created with genetic algorithms.[13] Initially presented at the 2013 ArchiLab exhibition in Orléans, France, they were among the earliest manifestations of this new approach, which today includes the work of architects, designers, and artists like Alisa Andrasek and Jose Sanchez, Marcos Cruz and Marjan Colletti, Andrew Kudless, David Ruy and Karel Klein, Jenny Sabin, and Daniel Widrig.

5. Conclusion

In the first section of this article, we presented the three levels of material hermeneutics. We distinguished between an empirical, social, and cultural level of analysis of technological artefacts. These three levels do not exclude each other, but are rather articulated in a hermeneutic circularity. The remainder of the article focused on the third level of analysis. In the second section, we relied on Panofsky's *Gothic Architecture and Scholasticism* in order to introduce the concept of mental habit or worldview, and to describe the Scholastic worldview and its principles. In the third section, we compared this worldview with the mechanistic and informationistic ones, presented respectively in Dijksterhuis (1961) and De Mul (1999). We argued that despite the differences, the Scholastic, mechanistic, and informationistic worldviews share the same epistemological postulates. We also argued that today we are facing the appearance of a new worldview we called "data worldview". The metaphysical model of the informationistic worldview is the line; while the metaphysical model of the data worldview is the dot. Throughout the article, we proposed examples from architecture, design, and visualization of knowledge according to what can be called an analogical method.

As for trees of knowledge in the case of the Scholastic worldview, we believe that the data worldview manifests itself in contemporary network visualizations. In particular, three peculiarities characterize

[13] https://www.centrepompidou.fr/cpv/resource/cdLqjpr/rynRjEj. Accessed May 1, 2020.

these visualizations: (1) Firstly, meaning is the result of the emergence of partial order rather than a rigid structure in which exceptions are excluded in principle. Meaning is, in other words, the output of algorithmic aggregations in which data are partially shown in their messiness; (2) Secondly, the meaning derived from data aggregations is always instable. New data can feed the algorithms, and the algorithms themselves are modified – in the case of algorithms of machine learning, they modify themselves, since they are both autonomous and adaptable; (3) Thirdly, lines or edges are less important, sometimes for mere reasons of readability, sometimes because in the use of machine learning for visualization, data are distributed on non-relational two- or three-dimensional spaces.[14] The first graph in Gaumont, Panhai, and Chavalarias (2018) is an interesting example: on the one end, it is a classic network visualization in which the graph has been spatialized with the Gephi software using the ForceAtlas2 algorithm. On the other, while edges still exists, they are visually submitted to the "colorful logic" of the nodes' clustering.[15]

Three postulates can be deduced from such actualizations of the data worldview: (1) Postulate of emergence, which is neither analysis nor perfect synthesis; (2) Postulate of non-programmability – or partial-programmability. Digital technologies like Big Data and algorithms of Machine Learning introduce both autonomy and adaptability in the machines – at least at a certain level of abstraction; (3) Postulate of control and/or manipulability, but without full knowledge of the rules and causes. While Big Data and algorithms of Machine Learning are certainly means for improving the capacities of prediction and control over reality, these same capacities increasingly depend on the ways machines "connect the dots" for us. Moreover, because of their opacity, machines themselves escape human control and prediction.

In conclusion, we can say that it would be contrary to the analogical method practiced in this article as well as to the data worldview itself to consider these postulates other than partial and provisory. It will be the goal of future researches to further explore this path.

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[14] See for instance the data visualizations created with UMAP algorithm (McInnes, Healy, Melville 2018). For a theoretical reflection on these visualizations, see Rodighiero and Romele (forthcoming).

[15] https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0201879. Accessed May 1, 2020.

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