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Physical Facets of Information, Information Materialization or the Grand Illusion †

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Abstract: Many researchers believe that information is physical. The goal of this paper is to show thatthis is only a grand illusion while in reality information in the strict sense belongs to the World of Structures, which is the scientific interpretation of the World of Plato Ideas or Forms. In addition, it is studied how the ideal information acquires a physical representation and is embedded in a physical carrier in the process of materialization. The process of idealization, which is inverse to materialization and in which information is extracted from its physical carrier as an ideal essence, is also discussed. People do not often make a distinction between abstract and ideal objects. That is why, herein, it is explicitly defined what an abstract object is and how an ideal object comes into being elucidating the difference between these entities.

Keywords: information; world of structures; physical world; mental world; system; carrier; representation; materialization; idealization

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1. Introduction

Information representsan important phenomenon in nature, society, and technology. At the same time, the huge variety of information manifestations beara common feature—when people encounter information, it is associated with some physical entity. As Bawden and Robinson write, "whenever we find information, we find it inscribed or encoded somehow in a physical medium of whatever kind" [1]. This situation brought many researchers to the conclusion that information is physical (cf., for example, [2–7]). Moreover, in the same venue, Deutsch and Marletto write, "Despite being physical, information also has a counterfactual character . . . " [8].

However, as it is demonstrated here, this is only a grand illusion. Information in the strict sense belongs to the World of Structures, which is the scientific manifestation of the World of Plato Ideas or Forms [9]. In addition, it is studied how the ideal information acquires a physical representation and is embedded in a physical carrier in the process of materialization. The process of idealization, which is inverse to materialization and in which information is extracted from its physical carrier as an ideal essence, is also discussed. Researchers often do not make a clear distinction between abstract and ideal systems. That is why here it is described explicitly what an abstract object is and how an ideal object comes into being, making possible the transparent understanding of the difference between abstract and ideal entities.

2. The Global Structure of the World

To understand the essence of information and its place in reality, we need to have a clear vision of the global structure of the world. This structure is described and modeled by the Existential Triad of the World [9] (cf. Figure 1).

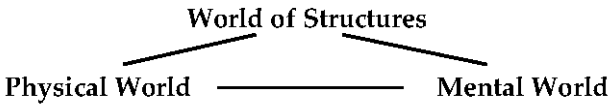

Figure 1. The Existential Triad of the World.

The Existential Triad of the World consists of three components: the Physical (Material) World, the Mental World, and the World of Structures [9]. The Physical (Material) World represents the physical reality studied by natural and technological sciences, the Mental World encompasses different forms and levels of mentality, and the World of Structures consists of various kinds and types of ideal structures.

There is scientific evidence of the distinction between the Physical (Material) World and the Mental World. The Mental World, as a rule, contains an image of the physical world. However, it can contain much more. For instance, according to the psychological object-relation theory of Melanie Klein, from the earliest moments of life, children construct imaginary "phantasies" creating the world of the "unreal real" [10,11]. Adults, especially creative individuals, also create mental images that do not exist in reality.

The most mysterious is the World of Structures. It is demonstrated that this world is the scientific incarnation of the world of Plato Ideas or Forms [12]. While the Physical and Mental Worlds are accessible by human senses, the World of Structures can be achieved only by the intellect as Plato predicted. To better understand the World of Structures, it is helpful to envision its necessity for the completion and elucidation of the interplay between two sensible worlds.

Indeed, it is known that there are different physical systems that bearthe same structure. In this situation, we can speak about physical structures that are instantiations or reflections of some ideal structure and in this sense, the physical systems have the same structure. At the same time, one physical system can have several structures. In this case, it is useful to assume existence of the unified ideal structure of the considered system while the physical structures are reflections of this unified structure. In such a way, ideal structures complete the configuration of the world as a whole.

This conclusion is also supported by the **straight line argument**, which is described below.

One of the basic concepts of the Euclidean geometry is a straight line. It is infinite in both directions and continuous in the classical sense. Assuming these properties, we ask whether it exists in the Physical World or in the Mental World.

Analyzing the first possibility, we observe that in the physical reality, there are no infinite objects and all lines cannot be continuous in the classical sense because they are formed from molecules and atoms.

Excluding the first possibility, it is possible to suggest that a straight line from the Euclidean geometry belongs to the Mental World, for example, in the individual mentality of mathematicians. However, if we analyze abstract objects in people's mentality, we see that there is no even a single infinite and continuous straight line there. In mentality, we have only descriptions and images of such a line because all images in the mentality are finite.

Thus, we come to the dilemma either to assume that such object as a straight line from the Euclidean geometry does not exist or to postulate such a world where it exists. This is exactly what Plato did for all general concepts and the World of Structures is the scientific instantiation of the world of Plato Ideas or Forms as it is demonstrated in [12]. *Acknowledging the existence of this world, we can deem that a straight line from the Euclidean geometry exists in this world.*

This shows that to have such an object as a straight line from the Euclidean geometry, we need the World of Structures.

Here is another observation in support of the necessity of World of Structures. Let us take an actual infinite set, even something assimple as the set $\boldsymbol{N}$ of all natural numbers. As we know, in physical reality, there are no infinite objects. In individual mentality, there are only descriptions and/or images of $\boldsymbol{N}$. At the same time, to have a meaningful set of mathematics, we need such an object as $\boldsymbol{N}$. Thus, we come to the conclusion that this infinite set exists only in the World of Structures and to have this object, we need this

world as a component of the world as a whole.The World of Structures makes the whole world complete.

This situation is analogous to some procedures in mathematics. For instance, the field of rational numbers is rendered complete by introducing irrational numbers, understanding the existence of which demands an essential mental effort. One more example is given by introduction of the point at infinity in projective geometry with the goal of completing geometrical spaces. In a similar way, it is possible to conceive the World of Structures as being situated at infinity from the physical world.

3. Materialization and Idealization of Information

In contrast to the opinion regardingthe physical nature of information, the general theory of information (GTI) places information per se in the ideal World of Structures, which is the scientific incarnation of the World of Plato Ideas or Forms [12]. According to the Ontological Principle O2 of the GTI and its additional forms [9] information plays the same role in the World of Structures as energy plays in the Physical (Material) World.

Note that although some researchers did not agree that information is physical, they did not identifyan appropriate place for information in our world [1,13].

We see that positioning of information in the World of Structures [14] looks contradictory to the assumption that information is physical and to the fact of the incessant presence of information in nature, society, and technology. The goal of this work is to solve this paradox explaining the connections between the ideal and material and further developing the approach to materialization introduced in [15].

According to the Ontological Principle O2 of the GTI and its additional forms [9] information plays the same role in the World of Structures as energy plays in the Physical (Material) World.

However, according to the Ontological Representability Principle (Ontological Principle O3) of the GTI, for any portion of information I,there is always arepresentation Q of this portion of information for a system R. Often this representation is material, and as a result, being materially represented, information becomes physical. Consequently, a physical representation of information can be treated as the materialization of this information.

Moreover, according to the Ontological Embodiment Principle (Ontological Principle O4) of the GTI, for any portion of information I,there is always acarrier C of this portion of information for a system R. This carrier is, as a rule, material, and this makes information even more physical. A physical carrier of information can alsobe treated as the materialization of this information, or more precisely, the materialization of the second level.

Now we can see that the paradox of the existing impact of such an ideal essence as information in the physical reality is caused by the very popular confusion of information per se, its representations, and carriers.

To better explain this, clarifying the meaning of materialization and why being ideal, information only seems physical to people, it would be useful to employthe Flying Metaphor.

4. The Flying Metaphor of Materialization

If we ask the question whether people can fly, the answer will be yes and no. Yes, an individual can take a plane or a helicopter and fly to another city, another country or even another continent. The answer is also no, because without technical means people cannot fly. So, to fly, an individual has to embed herself or himself into a technical device designed for flying.

In a similar way, to come to the physical world of people, information, which belongs to the ideal world of structures, must be embodied into a physical carrier. The process of this embodiment is called materialization.

Some researchers argue that information is physical because it acts on physical things. This is similar to the argument that birds can fly and people are birds because people can fly.

The difference between a portion of information, its representation, and its carrier is demonstrated by the following example. Let us consider a letter/text written/printed on a piece of paper. Then the text is a representation of information in this text while the piece

of paper is a carrier of this information. Note that the text is not information since the same information can be represented by another text.

This difference is the distinction between the essence of a phenomenon and its appearance where the representation of information is its appearance of the first order while the carrier of information is its appearance of the second order. There are also carriers that are appearances of higher orders. For instance, a text on a piece of paper is a representation of information in this text, the piece of paper is the carrier (appearance) of the second order. When this piece of paper is placedin an envelope, the envelope becomes the carrier (appearance) of the third order.When this envelope is carried by a mailman, truck or plane, themailman, truck or plane become carriers (appearances) of the fourth order.

Additional evidence for the ideal nature of information gives the situation when different physical things carry (provide) the same information. Thus, physical things are not portions of information but contain a portion of information. For instance, different mails (letters) with the same text definitely contain the same information. The same phrase written on the paper and displayed on the screen of the computer in both cases contains the same information. Even different sentences can contain the same information. All aforementionedmails, letters, printed or written phrases and sentences are physical embodiments of information. Physical embodiment of information is similar to clothes worn by people. A person wearing different outfits nevertheless remains the same person.

It is interesting that while stating information is physical, Landauer at the same time writes about the physical representation of information in the following words: "Information is not an abstract entity but exists only through a physical representation . . . " [2].

Further evidence for the ideal nature of information are suggested by Lombardi, Holik and Vanni, who providepersuasive arguments that there is only one kind of information, physically neutral, which can be encoded by means of classical or of quantum states [16].

Relations between portions of ideal information in the World of Structures induce relations between material representations of these portions of information. However, there is no direct correspondence between these relations. For instance, if a portion I of ideal information is a part of a portion J of ideal information, then this does not necessarily entail that a material representation MI of I is part of a material representation MJ of J.

Relations between material representations can also induce relations between the corresponding portions of ideal information. In this context, materialization of information has two meanings. First, materialization of information is the process of representing this information by a material object/system. Second, it is a material/physical representation of this information, that is, a result of the materialization process.

In the quantum world, materialization of information is performed by encoding it into quantum states [17].

There is also the process of information idealization, which goes in the opposite direction and is reciprocal but not always inverse to materialization of information. Both these processes are formally represented as named sets.

It is necessary to stress the difference between abstraction and idealization, between abstract and ideal objects.

Abstraction is built and lives (exists) in mentality, abolishing more and more properties of physical objects or mental objects on the lower level of abstraction.

Idealization reflects physical and mental objects in the realm of ideal structures.

Here are some examples:

An abstract straight line from the Euclidean geometry is only **imagined** and **described** by the Mind as perfectly straight and infinite in both directions.

An ideal straight line, which corresponds to the ideal image of the Euclidean geometry, **is** perfectly straight and infinite in both directions.

It is possible to build different models of the abstract straight line from the Euclidean geometry. To each of these models, an ideal straight line corresponds. Moreover, there is an ideal straight line, which unifies all these abstract straight lines.

5. Conclusions

Here, only the first steps in the study of information materialization and idealization are made. This process demands further theoretical study combined with experimental observations and analysis.

To conclude, we drawattention to the process of information mentalization. It represents a mirror image of information materialization. While information materialization is the physical embodiment of information, information mentalization is the mental personification of information.

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