European Journal of Science and Theology, August 2021, Vol.17, No.4, 59-72

UNINVESTIGATED AREAS OF REPRESENTATION IN SCIENCE

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(Received 14 February 2021, revised 29 March 2021)

Abstract

The problem of representation in Science (which is different from the issue of mental representations in the philosophy of mind) has been vastly examined by contemporary philosophers of Science, but their investigations embrace only the empirical sciences. Moreover, their main findings wrongly focus on one type of identification of the relation of representation, namely similarity and especially isomorphism. In this paper, I demonstrate that the issue of representation in Science has three shortcomings, or flaws, which need to be eliminated by opening new research areas and, in consequence, initiating new types of research. In more specific terms, these flaws lie in that the issue of representation: (1) is limited to the rather questionable identification of representation with similarity, (2) does not include representation in the technical and IT sciences, (3) does not distinguish between descriptive-explanatory (theoretical) and applied (prescriptive) sciences. Differences in representing, and in the types of represented and representing objects, demonstrate the most vivid difference in the natures of these sciences. Deeper inquiry into representation opens whole new areas for study, which in turn can lead to a richer and broader conception of science than those at hand today. It is surprising that the problem of representation, so crucial for the image of Science, has been so narrowly and selectively examined in contemporary Philosophy.

Keywords: representation, similarity, poiesis, artefact, virtual object

1. The overlooked problems of representation in Science

It would seem that the issue of representation in Science, or more precisely, the representation of reality in scientific cognition, has been thoroughly examined. In fact, judging by the extremely vast literature available in this area, one could say that Philosophy today has become satiated by it, that the subject has been fully exhausted, and that nothing more can be added to the existing assemblage of theories which address it. This, however, would be a misguided conclusion. Notwithstanding some sporadic, non-mainstream input, we can distinguish three important philosophical areas related to scientific representation which have as yet not been put to broader inquiry. I point to

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issues worth examining and partly explain why they are important. This is not a thorough, comprehensive investigation of the problem but merely a fragmentary overview. Neither is the subject literature I refer to fully representative.

First, inquiries into scientific representation focus almost entirely on the descriptive-explanatory empirical sciences and totally omit the technical and IT sciences. Hence, they significantly fail to explain the specifics of representation in these fields, although both are immensely important - not only because they co-form contemporary human world, but also for philosophical reasons, among others related to the specific character of the representation relations appearing in them. The basic properties of representation in the technical and IT sciences differ from those in the empirical sciences, which focus exclusively on cognitive tasks (mainly on constructing scientific theories for the examined areas of empirical reality). The representation conceptions which apply to the empirical sciences can quite certainly not be transposed to the technical and IT fields. This is all the more important as the representation relation is a basic cognitive factor in most cognition theories. Owing to the complexity of this problem I only allude to it here without going into it in more depth; although it is possible to find agreement between the representationist theory of knowledge and constructivism or idealistic conceptions (e.g. subjective idealism) [1].

Secondly, representation studies make no distinction between the specifics of representation in the theoretical and practical spheres of empirical sciences like, for instance, Sociology, Economics, Political science or Culture studies. In effect, there is a rather common tendency to transpose representation conceptions which function in the descriptive-explanatory (theoretical) empirical sciences - mainly natural - to the sphere of practical application, i.e. to the so-called applied sciences. This is well illustrated by references to Nancy Cartwright's representation conceptions for the natural sciences in reflections on economic models. Examples can be found in, among others: [2]. However, even superficial analyses show that such transpositions are questionable [3-4]. The representation relation in the natural sciences is different from that in so-called applied economics, which deal with economic processes that at the time of their projection are non-existent and only in the course of being 'mentally' created. Therefore, the application to them of the tool box of Science and fairy-tale conceptions developed by Cartwright for the investigation of economic modelling must be approached with utmost caution and reservation.

Thirdly, representation theories in the mentioned empirical fields are strikingly similar, and from the philosophical point of view appear to be not only naive, but in some respects erroneous. For greater clarity, it must also be said that current representation research concentrates itself in two areas - the philosophy of the empirical sciences and theories of mind, the latter mainly present in cognitivism (cognitivism has been evolving towards the empirical sciences, and today appears to embrace a group of empirical sciences which deal with cognition) and in Philosophy (which draws upon cognitivist research). In the first area, representation is understood as the representation of reality in scientific knowledge, in the second as the representation of reality in the mind of

the subject. These two representation relations are not independent of each other, but are treated as separate.

In the present paper I focus only on representation as the relation between scientific knowledge and reality, and pass over the issue of mental representation. Below, I will give a somewhat broader overview of the three aforementioned areas, which have been rarely been considered in studies of representation as the relation of knowledge to reality.

2. The representation relation in the empirical sciences

Today the representation relation is commonly seen as the founding-block of epistemological science theories, the belief being that it, together with models, constitutes the nature of scientific cognition. There is an abundance of literature devoted to this issue [5-19]. There are *case studies* [20], attempts at linking representation to other problem spheres [21], and classifications which order to-date findings (among others by Daniela Bailer-Jones [22] and Brandon Boesch [23]). Necessarily, most researchers in this field operate in the same intellectual environment [10, 24, 25], cross-refer to their respective findings and - quite unsurprisingly in this situation - formulate similar conclusions, although they do not necessarily form one 'school' in the traditional sense of the term.

This interaction has gradually led to the formation of a common approach to representation, and in effect, the representation conceptions developed since the 1980s have been quite alike and mainly based on one idea - that representation is similarity (usually reduced to isomorphism). Worth noting here is that the idea of the similarity - or isomorphism (isomorphism is a specific kind of similarity, the identicalness of structures) - of structures had been propounded by Bertrand Russell already in the 1920s (which subject literature fails to mention), so it is not so much new, as reactivated [1, p. 25-35]. Its weaker versions speak about partial isomorphism (Newton da Costa and Steven French [11]) or say that the representation relation is similarity in certain aspects or to a certain degree (Ronald N. Giere [16]).

Philosophers discuss and cautiously modify the elements of their representation theories, but do not tamper with their fundamental idea, i.e. the established perception of representation as similarity between knowledge and reality. Here, 'reality' is (usually silently) understood as the entirety of physical objects, and predominantly (and also silently) identified with beings. True, some authors distance themselves from identifying representation with similarity in their declarations, but in fact often pre-assume, or perhaps unconsciously smuggle through, the opposite.

The idea that the representation relation is similarity, and especially isomorphism, partial isomorphism, etc., carries disturbing flaws which cannot be eradicated, as they lie at its very core of this belief. I demonstrate this in my monograph [26]. The first that comes to mind is the copy realism (earlier known as naive realism) implied by similarity-based representation models. This is troublesome, as Philosophy has long since disavowed such perceptions of

reality. Let me quote the most obvious argument against copy realism. According to similarity-based representation conceptions, knowledge is to resemble truth, hence only some properties of both can be identical. However, it is difficult to prove that sentences or sequences of sentences resemble objects in reality, i.e. that sentence sequences possess certain properties that are identical with those of the objects they represent, or that one and the other have the same structure. Indeed, it is enough to compare any sentence with the object it addresses in whatever way to see that there can be no talk of any isomorphism, homomorphism or similarity [1].

Thus, despite the existence of numerous conceptions defining representation and vast literature on the subject, studies in the field appear to have stagnated. In Thomas Kuhn's words, one could say that inquiry into representation is in a 'normal science' phase, only 'normal' philosophy (unlike 'normal' science in Kuhn's understanding) is philosophy on the defensive, philosophy whose creative energy has waned and which is, in a sense, in the process of exhausting itself, or has even become epigonic. It operates with specific ideas and standards of thought beyond which it does not venture, and which can only be interpreted, expressed and supplemented by means of diverse concepts and notions. Its chief attribute is the absence of free thought.

This brief outline raises the question whether this almost universally accepted interpretation of representation should be upheld, or rather abandoned in favour of new assumptions and hypotheses on the nature and character of the representation relation, and resulting scholarly undertakings aimed at breaking out from the one-sidedness of 'similarity' conceptions, mapping out new ways of perceiving representation and eliminating such conceptions altogether. Instead of - as is predominantly the case today - weakening them and 'softening' similarity to a somewhat weaker relation of the to-date kind.

3. The representation relation in the technical sciences

As I already observed above, representation in the technical sciences, which are the technical base for implemented technologies, is not only not a subject of broader research today, but has not even been considered as a separate, important or, indeed, fundamental issue [27-29]. This is so despite the continuing presence of technology in the philosophical debate [30], among others in the philosophy of culture (where technology is seen as a dominating element of contemporary culture in its broadest sense), the philosophy of politics, and science studies. Philosophers of Science make only occasional reference to technology, and mainly on the margin of other issues. In fact, however, technology is important, because although it arguably fails to add to the question of the representation relation in the empirical sciences, it nonetheless poses important and quite specific philosophical challenges on the borderline between ontological and epistemological creation theory, among others related to creating reality and the existence modes of created objects (material artefacts). Also, the question of representation in the technical sciences

is the core issue when it comes to revealing their nature and the way in which they shape the human world.

This problem was already raised by the ancient Greeks (Heraclitus, Democritus, Plato and Aristotle), who defined *techne* as the creation of artefacts by means of imitation. Plato, and especially Aristotle, distinguished the poietic - technological - sciences, which they put in one class of creative activity with art. Aristotle wrote little about technology, but he contested Plato's *mimesis*-based view that technical artefacts (i.e. objects created by man by means of diverse technologies) are 'reflections' of natural things [31]. This is the earliest known dialogue on the representation relation to mention technology. However, although still addressed in the Middle Ages and at the outset of the modern era, the issue has been all but forgotten today. Contemporary philosophy investigates technology chiefly in the context of its social effects [32, 33], with relatively little reference to the nature of the technical sciences, their relation to the theoretical sciences or the differences between the two. Resolutions of the representation issue in the technical sciences are necessary for understanding what technology is as such, and must refer to the relation between humans, their products and reality (and, in a metaphysical sense, also the human-created world). Without understanding this relation there can be no understanding of technology and its role in the human world. Because, trivial as it may sound, it is technology that largely defines the contemporary world.

In the simplest and briefest interpretation, the technical sciences produce new, 'artificial' objects - artefacts - and through this change the world we live in: Nature becomes populated by artefacts, objects that are initially alien to it and do not belong to its primary equipment, which then either integrate with it or destroy the natural human environment. In any event, the interference of technology in reality and the human habitat changes both in many ways.

Although somewhat well-worn, the above observations nonetheless signal the disparity between representation in the technical and the theoretical empirical sciences. In the technical sciences, technical knowledge (usually derived from theoretical knowledge) first creates representations of an object - ideas, models, projects, mental prototypes, etc. - which are then actualised. This actualisation involves the 'realisation' (I have put realisation in inverted commas because ideas are also real in some variants of metaphysics e.g. in all Platonic variants), or, more precisely, materialisation of ideas, i.e. the creation from them of artefacts - in this case material objects. Artefacts are material realisations of ideas created by means of technical knowledge [34-38]. The primary ontic status of the objects of technology is that of non-material, unreal ideas (in the sense of their not belonging to Nature). Here I make use of the dual sense of 'idea' in the technical sciences, where it means both the knowledge projected to formulate the plan of an artefact, and the non-material object of this knowledge. In their initial phase, the ideas created by the subject of the technical sciences are non-material objects, subjective products of the subject, which are subsequently objectivised into objective non-material objects of technical knowledge. One can say that ideas initially exist in the world of Platonic ideas, or, in one of the

acceptable interpretations, in Popper' third world. Ideas, which are elements of knowledge or its non-material objects, represent objects which do not exist at the time the ideas are created, but are potential beings or pure form in the sense already propounded by the ancient Greek thinkers, especially Aristotle (more about which below).

The creation of artefacts can also be explained differently - based on Aristotelian metaphysics. This metaphysics is founded on categories of form and matter, "substance and attribute, existence and essence, hence that which is determining and determined, subordinating and subordinate, real and possible in a specific being" [39]. In these categories, one can say that first created in the technical sciences is the pure form - the possibility, essence and attributes - of an object which does not exist, therefore is not being in the Aristotelian sense. It is the subject that calls being into existence, i.e. combines essence (potency) with matter and the possible. Is the subject that connects pure form to matter. The result is material being - an artefact which is new and alien to Nature, but incorporated in it and a part of it from the moment it comes into being.

The ideas we are speaking about here (models of objects which do not exist in the natural world) are materialised, in other words - made, created. Appropriate in this case is reference to the Platonian and Aristotelian conception of *poiesis*. Plato considered nature to be the effect of *poiesis* - 'made' from ideas by a demiurge. Analogically, one can say that in technology ideas are materialised by a human subject which, like the Platonian demiurge, is the creator of new spheres of the world. Materialisation is *poiesis*-like activity which involves making, or transforming, ideas into material artefacts in the Platonian and Aristotelian sense. The model of an object (the idea) is the pure form of an artefact, and the artefact is the effect of a poietic act carried out on the idea.

Artefacts are materialisations, therefore they are also obvious expressions of ideas developed by the technical sciences. We can also say that artefacts *express or represent* ideas. Thus, the representation relation takes place between the idea (model) of an object and the realisation of this idea in the real world through a specific kind of technical *poiesis*. Ideas are the basis for the creation of artefacts, their intellectual fundament and matrix. Ideas are created from knowledge developed by the technical sciences, e.g. applied Biochemistry, Medicine, Engineering or Architecture. The ultimate source of this knowledge are the theoretical sciences, hence the source of the world's technification and the basis for the creation of artefacts are the basic sciences and the theoretical knowledge they generate. Incidentally, Science critics accuse all Science, including its theoretical (descriptive-explanatory) fields, of changing the world - and they are right. The beginning and source of technification are the theoretical sciences, also known as basic.

The creation of an artefact of the poietic kind begins with a mental projection formulated on the basis of scientific knowledge, usually derived from the theoretical science appropriate for the projection. The object of the projection first exists potentially, and is then made, created, materialised, and added to Nature - or, in a more general sense, to empirical reality. The material

objects of the technical sciences do not exist at the time research into them is launched, or, more precisely, at the outset of the projection of new objects of technology. The first research phase involves the creation of ideas, or potential, non-material objects, and it is only in the second phase, the *poiesis* phase, that the objective ideas formulated in the first are materialised.

In light of the above, the conclusion is that, *representation in the technical sciences is the relation between an idea and its appropriate artefact, or, most frequently, a whole set of artefacts - both those that already exist and those that have not yet been created and are only possible* (in the sense that they have been projected and accepted by the laws of Science (here one can speak about a nomological possibility, or non-contradiction with scientific laws), i.e. possess and idea or a model). This is how e.g. cars, aircraft or medicines are projected. The set of objects which represent a given (represented) idea contains both artefacts that have been created and those that are only potential. In effect, the set of objects that represent an idea is ontologically complex, as it embraces objects belonging to two modes of existence: those that actually exist in empirical reality, and those that exist potentially, and are to be created in the future. This set changes over time, i.e. it is temporary, inconstant, changeable and accumulative, moreover, some of its materially created elements undergo exhaustion and decay. In other words, the artefacts that represent (or express, or are created 'from') a given idea constitute an open set which includes realised artefacts that have been technically created in the form of material equivalents of ideas, and possible artefacts that have not yet been created. This circumstance, alongside others, complicates the representation issue because the represented objects - ideas - exist in the non-material world, whereas the objects that represent them exist in material and potential reality. It must be noted that these complications are of an ontological nature, and therefore rarely addressed in the representation debate.

This summary, very incomplete and semi-hypothetical picture certainly demands further research, but it shows that representation in the technical sciences has a different character and, one may say, a different sense than representation in the theoretical fields. In both types of sciences representation is the relation between knowledge and reality, and this most general property, common to both, constitutes the identity of representation - we can speak about representation in both cases. However, in addressing the differences, it must be emphasised that the representation relation in the technical sciences is the 'reverse' of the representation relation in the descriptive-explanatory (theoretical) fields. In the former, the idea (model) is the representing object and empirical reality the represented object. In the technical sciences the represented object is the idea (model) and the representing object an open set of artefacts. This reversal of the representation relation results from a fundamental difference between both kinds of science. In the theoretical (descriptive-explanatory) sciences the aim is the cognitive perception of empirical reality, the perception of what exists, what is given - Nature in its primal form, unviolated by human interference. In the technical sciences on the other hand, the aim is to project

objects (ideas, models) which do not exist in empirical reality, and which humans intend to call into existence. Here, humans function as creators of a new world and not just perceivers of existing reality - their role is similar that of Plato's demiurge.

In the basic sciences, the main role of representation is the cognitive presentation of the world. In the technical sciences the human subject creates new worlds. However, the human subject does not do this randomly, does not create fictitious improbabilities, but bases what is being created on scientific knowledge.

Here, representation is a 'reflection' of human ideas in the material world, which is changed by the represented ideas. The poietic transformation of the world by human ideas, i.e. the material representation of these ideas, is evidence - though admittedly inconclusive - that technology, its ideas and its artefacts belong to the human being, who first acquired theoretical knowledge about them. This to some degree complicates the philosophically much addressed issue of human alienation from a technologically transformed world.

4. Representation and theoretical sciences vs. applied sciences

When investigating representation, one must remember that alongside the theoretical (descriptive-explanatory) areas of Science there are also areas that focus on what is known as practical application, i.e. the projecting (modelling) of new processes, objects, facts or situations. For instance, economics fulfil both descriptive-explanatory tasks by formulating knowledge about existing economic processes, as well as projection tasks involving the planning of new, still non-existent processes. Assuming that knowledge has the form of models, one can say that theoretical economics create models of existing economic processes or phenomena, and applied economics models of processes that are potential, conceived, non-existent in economic praxis, in other words, processes that are desirable (e.g. to raise economic indices, intensify economic growth or curb inflation).

These two areas - applied and theoretical-explanatory - are connected. For example, theoretical findings which describe and explain existing economic processes can serve to create models of new processes, which in turn can improve certain areas of economic praxis. Thus, the descriptive-explanatory phase is followed by a poietic phase in which applied science draws upon theoretical findings.

The situation in the empirical applied sciences is different from that in the theoretical sciences, where the objects of study really exist and the scientist's task is to represent them in the categories of knowledge. In the applied sciences, the objects that are projected by the creation of their models, or sets of sentences that describe them, do not exist in empirical reality. One can say, therefore, that knowledge about these objects has no cognitive value, and, most of all, that it is not real in the classical correspondence sense, because the objects about which this knowledge speaks exist only potentially, as projects or ideas. In more

cautious and only suggestive terms, one could say that the epistemic status of conceptions in the applied sciences is different from that of explanatory theories. Knowledge in the applied sciences becomes real when the objects it refers to come into being. Therefore, there is an epistemological difficulty here, accompanied by an ontological one, which also influences the understanding of representation in the applied sciences. Because explaining applied science and its appropriate representation category would require the establishment of a category of currently non-existent potential objects and their truthfulness (or alternative cognitive value). Models (ideas) created in the applied sciences have the character of existential projects, they are recipes for the transformation, including the enrichment, of existing reality, for supplementing it with new objects, which, incidentally, often influence that what exists. E.g. all 'supplementation' of Nature by technical inventions like aircraft, cars, asphalt roads and cities greatly influences the pure, uncontaminated condition of Nature.

This duality of the character and tasks of all empirical sciences is of crucial importance for the representation issue. The applied sciences, or, more precisely, the areas of the practical application of the empirical sciences, contain a representation relation that differs from that in the theoretical, explanatory sciences. In the applied sciences objects are not cognised in the same way as they are in the theoretical fields, i.e. they are not *presented* as knowledge relating to really existing things. Objects the applied sciences deal with do not exist in empirical reality - e.g. postulated economic relations have not yet been introduced into economic praxis. Similarly not yet existent is medication when it is being developed by means of, say, chemical synthesis or extraction from natural substances.

Generally speaking, in their research phase the objects of the applied sciences exist only as possible but unrealised, unmaterialised objects. Once they have materialised, applied scientists begin to treat them differently. They test the created objects, processes, etc. for compatibility with their models, for features unaccounted for in the projecting phase that could run the original conception, and examine their functionality to see if they work as originally planned. For example, newly created economic processes or legislatively established social relations are, among others, examined for conformance with their potential (project phase) equivalents, possession of properties postulated in the model, and the possible existence of previously overlooked flaws that could crucially impede them.

Thus, depending on a project's realisation phase, two kinds of representation relations can be distinguished in the applied sciences. The first takes place between the models that project objects and the (potential) objects that are projected: a project (model) is created, and then an object postulated by the model is made (built, adjusted to the model). So here *the object represents the model*.

The other relation comes in after the projecting model has been realised - then knowledge describes completed, existing objects, phenomena, processes, etc. and scientists examine them. In this phase, after the model has been realised,

the situation resembles that in the descriptive-explanatory sciences: *the represented object is an object of knowledge, and the representing object is knowledge, e.g. expressed by a model* (which, to distinguish it from a projecting model, we can call a descriptive-explanatory model). It is easy to see that the knowledge in phase one (the projecting model) and phase two (the descriptive-explanatory model) as well as the potential objects in phase one and the created objects in phase two are not the same. In the most general terms, neither the project nor its realisation are perfect, hence a realised project differs, or can differ, from a postulated one.

Two moments are of key importance for representation in the applied sciences. First, there are two representation relations. In the projecting phase the represented object is a projecting model of postulated objects, phenomena, processes, etc., and the representing object are these very objects, phenomena and processes, which the model postulates. In the next, post-poietic phase, when the project has been realised, the second representation relation comes into play, in which descriptive-explanatory knowledge represents the objects projected in the first phase. *Representation in the projecting phase is, therefore, the reverse of the representation relation in the second phase, which is typical for the descriptive-explanatory sciences.*

There are also two representation relations in the technical sciences, and they are similar to those in applied empirical fields like sociology, political science or economics. For practical ends, the technical sciences make use of theoretical knowledge accumulated by the natural sciences (e.g. Newtonian mechanics, Quantum mechanics, chemical and biological theory).

5. The representation relation in the IT sciences

Representation in the IT (computer) sciences appears to be similar to that in the technical and empirical applied sciences, however there are some differences: specific about the IT sciences is that its objects are virtual [40; J. Danaher, *Philosophical Disquisitions*, 2017, https://ieet.org/index.php/IEET2/more/Danaher20170918], which is problematic, because the ontic status of virtual objects has not been sufficiently investigated. The similarity is that in the IT sciences, like in the technical and empirical applied sciences, the first to be created are models, on whose basis then virtual objects are created, which, although not a part of nature, exist in a certain sense. This, of course, gives rise to the question about the ontic status of such objects [41], which, as I have said, has not yet been fully researched. Such research is necessary for revealing the representation relation in the IT sciences, because the ontic status of virtual objects is essential to representation in these fields. This status can be differently explained, e.g. by reference to the Platonian world of ideas, Aristotelian form and potency, Franz Brentano's intentionality conception, or Popper's three worlds theory [42]. Another problem is that philosophical inquiry into the nature of computer science is not very advanced [43, 44], which is surprising in view of the immeasurable impact of global computerisation on human life and the deluge

of literature on the subject. All one actually encounters here are hypothetical claims that representation in the IT sciences is similar to that in the applied and technical fields (because here too models project new realities), or that it is different because the projected and realised objects are virtual, hence not a part of empirical reality.

6. Conclusions

If we accept the above-outlined interpretation of representation in the applied and technical sciences, and probably - though rather hypothetically and with considerable reservation - in the IT sciences, we will see that the representation relation in them is the 'reverse' of this relation in the descriptive-explanatory (theoretical) fields. This reversal is connected with the differences in the character of these sciences. The descriptive-explanatory sciences generate knowledge about existing segments of reality, which exist at the time they are researched. In other fields like Engineering**,** the task is to create new objects which do not exist when researched. These characterize the difference between these sciences, and the relation between knowledge and reality in them. In the applied descriptive-explanatory fields the represented object is an idea, knowledge (a model or set of sentences), and the object that represents this idea is a material object, an artefact, or a potential (also virtual) object. Possible, non-material, virtual objects do appear in the applied empirical sciences, but they are the only objects of the IT sciences. The world of science is to a large degree a created world, the effect of a specific kind of *poesis*, which, as it appears, is present not only in art. Artefacts, possible beings and virtual objects [45-48] are increasingly present not only in the world of human life as co-creators of the Anthropocene, but also in the non-material world, which is equally important for humans as their material surroundings. Ideas formulated by science drive change both in the material and spiritual human world, in other words, in collective awareness.

Thus, when we compare the empirical theoretical sciences with the remaining discussed fields, we see that the role of knowledge and the object in the latter is undergoing change: the represented object is an idea, while the artefact, the material object, is what represents the idea. In the descriptive-explanatory sciences the represented object is natural or social, and represented by the knowledge about it.

Representation in the empirical applied sciences, technical sciences and probably the IT sciences - generally in the poietic sciences - involves the adaptation of creations (material or non-material) to ideas, or, more precisely, the material actualisation of ideas. Whereas in the theoretical empirical sciences it is ideas (models) that are adapted to existing material objects. The second difference is in the ontic status of these sciences' objects. It is the production, creation, or, generally speaking the 'making' of objects, also non-material ones, that is playing an increasing role in science, not the cognitive perception of these objects, which are independent of us. In the poietic sciences, the objects that

represent knowledge - ideas relating to what does not exist and is only possible - are at the same time our products, and therefore change the existing reality. Paradoxically, representation in art is similar in character, and is, in fact, the main attribute of art.

Representation in the applied technical and IT sciences must be approached on the ontological level, because these fields operate with objects that are not 'standard' objects of empirical reality (Nature or society). They are the products of *poiesis*, and can be both 'made' and material, as well as non-material (virtual). They are extremely interesting from the ontological, and therefore also epistemological, and even anthropological point of view. Indeed, human reality is becoming increasingly 'artificial', with fewer and fewer ties to primal nature. Humans live amidst their own creations, from which they feel alienated and which they cannot understand, and whose constant influx violates their belief in the stability of their surroundings.

It must be added here that the ontic status of the material artefacts manufactured by technology and the virtual objects created with the help of IT operations is doubtful, among others because the attribute of being is autonomy, whereas the mentioned objects are, at least in their genesis, completely human-dependent. This poses some essential questions: can they become autonomous through their existence? And, once autonomous, can they have any influence on the humans who called them into being, or even - as countless prophecies and diagnoses by contemporary writers, futurists, scientists (and even philosophers) warn - threaten or dominate them?

All the above-discussed issues indicate the need to reinstate the ontological categories that have been excluded from the epistemological debate in contemporary Philosophy of science. They are also important for philosophical anthropology, because without a doubt humans today live in an increasingly artificial, technified and computerised world, a world of artefacts and virtual objects, which retroactively causes change in humans themselves. It is necessary to explore the deeper layers of this world, not only in order to learn more about our habitat, but also about the changes taking place in human beings.

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