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Engineering and the dual nature of technical artefacts

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An analysis of the descriptions of technical artefacts by engineers shows that they use structural and functional concepts in their descriptions. On the basis of this I argue that engineers use a structure-function conception of technical artefacts: technical artefacts are physical structures with functional properties. Taking into account the different nature of structural (physical) and functional properties, I put forward the claim that technical artefacts have a dual nature. This dual nature is interpreted in an epistemological and an ontological sense. In order to explicate the role of human intentions in the ontology of technical artefacts the paper closes with a brief examination of the relation between this dual nature conception of technical artefacts and Thomasson's theory of the metaphysical status of artefact kinds as mind-dependent entities.

Key words: Technical artefact, Technical function, Physical structure, Intentionality, Dual nature, Ontology of technical artefacts
JEL classifications: B40, A12

1. Technical artefacts

One of the core activities of engineers is the design, development and making of technical artefacts. By doing so, they enrich the world we live in with new kinds of objects such as bicycles, cars, copiers, computers, coffee machines, air planes and so on. By creating new technical artefacts engineers as well as technicians and craftsmen produce a world of our own making. Our world is full of technical devices to such an extent that modern Western life has become almost completely dependent on technology. Winner (1986, ch. 1), therefore, characterises technology as a life-form. In spite of their ubiquitous presence and pervasive influence the nature of technical artefacts raises many questions. There is still no generally accepted view or theory of what kind of objects technical artefacts are.

The world of technical artefacts is generally taken to be different from the natural world. In contrast to natural objects, technical artefacts are considered to be things that are intentionally made by human beings (Hilpinen, 2004). Technical artefacts are indeed often

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characterised as intentionally made physical constructions that, on condition that they are functioning and used properly, support users in realising their goals. Such a rough characterisation raises questions about whether technical artefacts are mere physical constructions, about what it means for a technical artefact to function properly or to be used properly, about how technical artefacts are related to human intentions or human goals, or whether there is a clear demarcation line between technical artefacts and natural objects.[1]

In particular the ontology of technical artefacts raises deep philosophical issues. The artefactual world has a ring to it of being 'artificial', that is, 'lacking in natural quality' or even 'being feigned or faked'. Indeed, the artefactual world is often taken to be ontologically inferior to the natural world, in the sense that the existence of technical artefacts is mind-dependent (Baker, 2008) or that the existence of technical artefacts is dependent on the existence of natural objects. For instance, as a technical artefact, the desk on which I am writing this article may be claimed not to exist since objects of the kind called 'desk' do not fit into the basic ontological structure of the world. Only as a physical object the desk really exists, and as a physical object it is composed of natural/physical entities like molecules, atoms or elementary particles. In case the desk as a technical artefact is attributed some ontological status, this status is usually taken to be subordinate to or dependent on the ontological status of natural objects or to be dependent on the existence of human minds. The idea that technical artefacts are inferior to natural objects may be traced back to ideas of Plato and Aristotle about technical artefacts. For Plato technology is about mimicking nature, and Aristotle maintained that technical artefacts lack a nature that he defines as an intrinsic principle of change (Ross, 1970, p. 192b).

The starting point for my analysis of the nature of technical artefacts is the way engineers describe and conceive of technical artefacts (Section 2). The reason for turning to engineering practice is that engineers are experts in designing, making, analysing and describing technical artefacts and so their way of describing and conceiving technical artefacts may be taken to be a fruitful anchor point in our quest for the nature of technical artefacts. In a similar way we turn to the descriptions of physical phenomena and the underlying conceptions of the physical world provided by the physical sciences when we are interested in the nature of the physical world. I argue that engineers conceive of technical artefacts as physical objects with a function. Taking this conception as my guide I put forward the claim that technical artefacts have a dual nature (Section 3). Because the functional properties of technical artefacts are intimately related to human intentions, technical artefacts have to be described (conceived) in terms of concepts stemming from two different conceptual frameworks, namely a physical and an intentional one. It is the combination of physical and intentions-related properties that implies that technical artefacts have a hybrid, dual nature.

The claim that technical artefacts have a dual nature may be interpreted in an epistemological and ontological sense. Roughly, epistemologically the dual nature thesis implies that there are two different kinds of knowledge of technical artefacts, namely knowledge about its physical and knowledge about its functional properties, and ontologically that physical objects or properties as well as human intentions are constitutive

[1] In my opinion there is no clear dividing line between technical artefacts and natural objects. Whenever I speak about technical artefacts in the following I have in mind 'engineered artefacts', that is technical artefacts that are clearly different from natural objects. So I will not deal with issues about borderline cases. Furthermore, I leave out of consideration engineered biological organisms.

for something to be a technical artefact.[1] It is one thing to claim that human intentions play a constitutive role with regard to technical artefacts, it is another to spell out in more detail whose and what kind of intentions are involved. In order to further explicate the role of human intentions in the ontological version of the dual nature thesis I will discuss briefly Thomasson's (2003, 2007) recent analysis of the metaphysical status of artefacts and artefact kinds and apply it to technical artefacts (Section 4). I will argue that the intentions of designers and makers, in contrast to those of users, are ontologically relevant.

2. The engineer's conception of technical artefacts

Consider the following description of a computer mouse (United States patent no. 3,541,541):[2]

> An X–Y position indicator control for movement by the hand over any surface to move a cursor over the display on a cathode ray tube, the indicator control generating signals indicating its position to cause a cursor to be displayed on the tube at the corresponding position. The indicator control mechanism contains X and Y position wheels mounted perpendicular to each other, which rotate according to the X and Y movement of the mechanism, and which operate rheostats to send signals along a wire to a computer which controls the CRT display.

In this description, which may be taken to be typical of how engineers describe technical artefacts, three different elements, together characterising what a computer mouse is, may be discerned; the description states:

- the function of the patented device (what it is for): controlling an X–Y position indicator;
- what the device physically/materially consists of (what is it made of): two wheels that can move etc.;
- how the device is to be operated in order to achieve its function (how to use it): by moving the device with the hand over a surface.

So, the device is described in terms of its functional properties, its physical/material properties and the actions that have to be performed in order realise its function (its manual).[3]

Let me first focus on the role of functional and physical/material properties in the engineer's description of technical artefacts. I will refer to a description of a technical artefact only in terms of its physical/material properties (which includes geometrical and chemical properties) as a *structural description*. Whenever a technical artefact is described only in terms of its function (its functional properties) I will speak of a *functional description*. A prototypical example of a structural description of an object *x* is: 'Object *x* has such and such mass, colour, shape, et cetera'; it is the description of an object from the point of view of the physical sciences.

[1] Throughout this paper I assume a 'background' ontology figuring physical objects and human intentions (mental states). I take such a background ontology simply for granted and do not address issues about how mental states are ontologically related to the physical world.

[2] Available from http://www.uspto.gov/patft [date last accessed 7 April 2009].

[3] In the following quote, taken from an encyclopaedia for the general public, a computer mouse is described in similar kinds of terms: 'In computing, a mouse (plural mice or mouses) functions as a pointing device by detecting two-dimensional motion relative to its supporting surface. Physically, a mouse consists of a small case, held under one of the user's hands, with one or more buttons. It sometimes features other elements, such as "wheels", which allow the user to perform various system-dependent operations, or extra buttons or features can add more control or dimensional input. The mouse's motion typically translates into the motion of a pointer on a display'; see http://en.wikipedia.org/wiki/Computer_mouse [date last accessed 17 August 2007].

A prototypical example of a functional description is: '*x* is for *y-ing*' (e.g. for transporting benzene, for cutting steel plates, for drying hair); a functional description is closely tied to a user's perspective.[1] The above description of a computer mouse is clearly a hybrid description in the sense that it makes use of both structural and functional concepts.[2]

Apart from mixed functional and structural descriptions, we also encounter in engineering practice descriptions of technical artefacts in terms of purely functional or structural properties. Purely functional representations of technical artefacts play an important role in the early phases of design processes.[3] They have the form of black box descriptions, in which the object of design is specified only in terms of its input and output (see Figure 1).

Especially in the context of innovative design, technical artefacts are characterised at the beginning of design processes as means to achieve certain ends, that is, in terms of their function; structural characterisations are avoided because they already restrict the solution space. Purely physical/geometrical descriptions are to be found in the final stages of design processes. The reason is simply that without a physical/geometrical description of an artefact it will not be possible to actually make it.[4] As long as the description contains parts, which are characterised only in a functional way, it will not be possible to produce the artefact (for it is not known what is inside the functionally described black box). If the design of a technical artefact, as the outcome of a design process, is taken to be a blueprint for its fabrication, then that design has to contain a structural description of all the relevant physical/material features of the technical artefact. Designing a technical artefact may, therefore, be taken to be a process in which, among other things, a functional description of the object of design is transformed or translated into a structural description.

The role of structural and functional properties in characterising a technical artefact also comes to the fore when it is taken to be the material realisation or the embodiment of a design. Roughly, a design in this sense is a purposeful or functional arrangement of physical/material objects and is based on the adjustment of means to an end (purpose). The design of a technical artefact stresses its teleological nature, that is, its *for*-ness. A functional description of a design (including its functional decomposition) contains only half of the description of a technical artefact, since different physical structures may realise the same (sub)function (the multi-realisability of functions). Conversely, a structural description leaves out the functional properties of (parts of) the artefact; it does not specify what the technical artefact is for and therefore ignores its design features. Neither the functional nor the structural descriptions by themselves capture all aspects of the design of a technical artefact; the functional one leaves out the structural, and the structural one the functional properties. So we reach the conclusion that the description of an object as a technical artefact requires the specification of its relevant structural and functional properties (relevant in the light of being a means to a certain end).

In sum, the use of structural and functional properties for the description of technical artefacts is *de facto* indispensable in the engineering practice of designing and making

[1] Note that in a functional description also structural concepts may occur in the phrase replacing *y-ing*; this does not imply, however, that the object *x* itself is described (partly) in a structural way.

[2] For some concepts used in the description of the computer mouse, for instance the concept of a wheel, it may at first sight not be clear whether it is a functional or a structural concept. Here I simply assume that on closer inspection such concepts can be analysed either in a structural way (an object with a circular form etc.) or in a functional way (an object for turning around etc.)

[3] For examples, see ASM Handbook (*Materials Selection and Design* Vol. 20, 1997, p. 22 ff) and Otto and Wood (2001, ch. 5).

[4] Purely structural descriptions of technical artefacts may be found in ISO norms for standardised technical objects, such as ISO norm 10663 for hexagon nuts with flange (fine pitch thread).

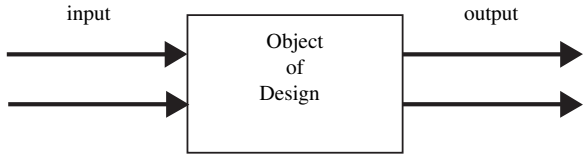

Fig. 1. *A purely functional (black box) description of a technical artefact.*

technical artefacts.[1] What about the third element, the manual, that describes the way to use a technical artefact? From a user perspective such a description is, of course, indispensable, and that is probably the reason why it is often inlcuded in engineering descriptions of technical artefacts. From a strict engineering perspective, however, with its focus on designing and making technical artefacts it is not. Ideally any constraints originating from how to use the technical artefact to be designed and made, are taken care of in terms of constraints on its input and output. The manual by itself does not add any *descriptive* information about the technical artefact over and above the information contained in the structural and functional descriptions. From an engineering point of view, therefore, technical artefacts may be simply characterised as physical objects with a function. I will refer to this characterisation as the engineering *structure–function conception* of technical artefacts.

3. The dual nature of technical artefacts

By itself the structure–function conception of technical artefacts does not imply that they have a dual nature. It all depends on how the notion of technical function is to be interpreted. In case technical functions are taken to be physical capacities, then technical artefacts are, according to the structure–function conception, simply physical objects. However, the idea that technical functions may be equated to physical capacities raises insurmountable difficulties, and therefore technical functions are usually taken to be closely related to human intentions (Perlman, 2004). If we do so, the structure–function conception leads to the conclusion that technical artefacts have a dual nature (Kroes and Meijers, 2006; Kroes, 2002). Then the structural and functional properties of technical artefacts turn out to be different in kind since they are related to two fundamentally different ways of viewing or conceptualising our world. The *physical* view, encountered in the physical sciences, conceives of the world as consisting of physical objects that interact causally. The *intentional* view, underlying roughly the humanities and social sciences, conceives of parts of the world as consisting of agents, primarily human beings, who intentionally represent the world and act on it on the basis of reasons. In so far as technical artefacts are physical objects they fit into the physical conception of the world; their physical properties can be accounted for in this view. That, however, is not possible for their functional properties, since, leaving apart the biological sciences, functional properties have no place in the physical conception of the world. In so far as they have intentionality-related functions, technical artefacts fit into the intentional conception; in this conception their functional properties can be accounted for by relating them to human ends and purposes. So, technical artefacts have a dual nature because they are, on the one hand, physical structures that realise, on the other hand, functions, which refer to human intentionality.

[1] Cf. also Dennett's discussion of the design stance (Dennett, 1987, ch. 2).

Technical artefacts are hybrid objects in the sense that these two different conceptualisations are necessary to account for the nature of technical artefacts. The physical conceptualisation may account for the way the artefact works in terms of physical processes. But as a mere physical object, it is not a technical artefact. Without its function, the object loses its status as a technical artefact. The intentional conceptualisation may account for the function of a technical artefact in terms of what it is for, and relate this function to the realisation of human ends. But a functional (means-end) description of a technical artefact effectively black boxes its physical structure. As pointed out earlier, such a description has the structure of '*x* is for *y-ing*', where *x* stands for a physical object and *y-ing* for some activity. Of course, the description of *y-ing* will contain physical concepts, but that does not provide a more detailed description of *x* beyond the fact that *x* is some physical object.

Exactly how the physical and the intentional conceptualisations of the world are to be combined in the case of the technical artefacts is an intriguing issue (for an interesting attempt, see Searle, 1995). This is more or less a special case of the general mind–body problem that remains a troublesome topic within philosophy. With regard to the development of a coherent framework for describing technical artefacts, the notion of function plays a key role. If functions of technical artefacts are seen primarily as realised in the physical objects involved, the question remains how these functions are related to the mental states of human individuals, which form the core of the intentional conceptualisation. If, on the contrary, functions are seen primarily as patterns of mental states and exist, so to speak, in the heads of designers and users of technical artefacts, it becomes mysterious how a function relates to the physical substrate of a particular artefact. Vermaas and Houkes (2006) have developed a function theory that tries to take into account both aspects of functions of technical artefacts.[1]

The notion of function appears to be a kind of 'bridge-concept' between the physical and intentional conceptualisations of the world since the function of a technical artefact is closely related to its physical structure on the one hand, and to human intentions with regard to that artefact on the other. This means that the structure–function conception of technical artefacts involves three key notions, namely the notion of a physical structure, of a (technical) function and of a context of intentional human action (see Figure 2).[2] Two specific contexts of intentional human action are of particular interest, namely the engineering design context and the user context. In the engineering design context the focus is on inventing/constructing a physical structure that will realise a given function (or that satisfies a list of functional requirements or of design specifications). Here, the intimate relation between the function of a technical artefact and its physical make-up shows itself and the context of human action often moves to the background. In the user context, on the contrary, the function of a technical artefact is primarily related to the ends of human actions; what matters here is how the use plan of a technical artefact may contribute to realising those ends (Houkes *et al.*, 2002). Thus, the function of a technical artefact is closely related, on the one hand, to its physical structure, and on the other hand to its use plan (that is, human actions).

[1] For a discussion of various aspects of the dual nature of technical artefacts, see the special issue 'The dual nature of technical artefacts' of *Studies in History and Philosophy of Science*, vol. 37, no. 1, 2006.

[2] The arrows stand for conceptual implication. In a more or less similar way, Losonsky (1990, p. 84) analyses the nature of artefacts in terms of the following three features: internal structure, purpose and manner of use. Simon (1996 [1969]) analyses the notion of a technical artefact in terms of what he calls its character (that is, its physical structure), its goal or purpose and its environment.

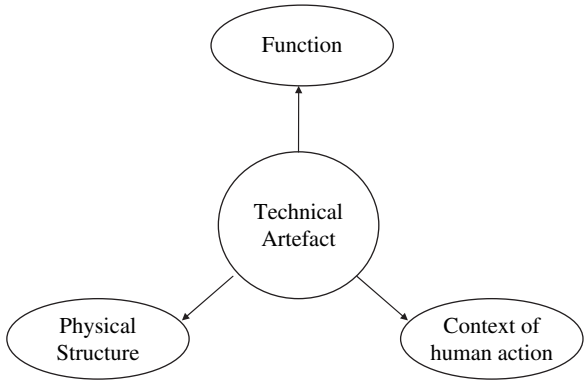

Fig. 2. *A conceptual anatomy of the notion of a technical artefact.*

Note that the intimate relationship between the function of a technical artefact and its physical structure introduces an interesting difference between technical artefacts and social objects like money. The history of money shows that in the course of time all kind of objects have been used as money, up to digital information on a chip card in recent times. These different kinds of objects do not perform the function of money on the basis of their (common) physical characteristics. As Searle (1995) has pointed out, money performs its function as legal tender on the basis of collective intentionality. Whether a €10 note can perform its function as money depends on the intentions of people with regard to it. Only if it is generally accepted as (considered to be) a €10 note will it be able to perform its function as money. In contrast to technical artefacts, there is no close connection between function and physical structure in the case of social objects.

So far we have argued that the structure–function conception of technical artefacts combined with the idea that technical functions are closely related to human intentions leads to the conclusion that technical artefacts have a dual nature in the sense that concepts from two different conceptual frameworks are necessary to adequately describe technical artefacts. From an epistemological point of view this 'conceptual' version of the dual nature thesis may be interpreted as saying that knowledge about technical artefacts falls apart in two distinct kinds. This is related to the fact that functional and structural descriptions of a technical artefact are logically distinct. In a nutshell, the functional description does not entail the structural description because functions are multiple realisable. Conversely, the functional description cannot be derived logically from the structural one; the functional description implies claims about what a technical artefact ought to do or is supposed to do and such claims cannot be derived from a structural description without violating the infamous is–ought dichotomy (for more details, see Kroes, 2006). It does not follow that functional and structural descriptions are completely independent since the function and structure of a technical artefact constrain each other (not any structure can perform any function). So knowledge claims about structural and functional properties are logically distinct.

From an ontological point of view the dual nature thesis may be interpreted as stating that technical artefacts are constituted by physical objects or properties and by human intentions.[1] This means that technical artefacts are mind-dependent entities and as such

[1] I will not enter into a discussion of what kind of constitution relation obtains between a technical artefact and its constitutive parts; see, for instance, Houkes and Meijers (2006) and Kroes (2009).

are ontologically different from physical objects. An object cannot be a technical artefact by virtue of its physical properties alone. Being a technical artefact also involves functional properties and these in turn involve human intentions (mental states). This means that technical artefacts are relational entities (Meijers, 2001).

In this form the ontological interpetation of the dual nature thesis is of a very general nature: some human intentions are relevant for being a technical artefact. In the next section I will present an attempt to fill in, in more detail, the role of human intentions with regard to being a technical artefact.

4. Human intentions and the ontology of technical artefacts

The ontological interpretation of the dual nature thesis immediately raises issues about whose mental states and what kind of mental states are involved. Suppose somebody sees an object, thinks that it will make a good screwdriver and uses it successfully to drive screws. So the object has the relevant physical capacities for driving screws. Are these physical capacities and the mental states of this single user with regard to this object sufficient to make this object into a screwdriver, to constitute it as a technical artefact of the kind screwdriver? The situation may be one in which the object involved may be, in fact, a knife that is incidentally used *as* a screwdriver. In that case, it seems hard to defend that the mental states of this user are ontologically relevant; they do not turn the object, the knife, into a screwdriver. But what is it that makes the object involved a knife in the first place? Is that the fact that objects of that kind are standardly being used as knives within a certain community or because they were designed and made as knives? In the former case the intentions of users are ontologically significant, in the latter the intentions of designers and makers. Suppose that within some community of users a practice develops of routinely using knives for driving screws. Is such a standardised form of collective use sufficient to make an ontological difference?

By itself the dual nature claim is mute on the intricate issue of whose mental states are relevant for constituting an object as an instance of a particular artefact kind. It simply claims that some human intentions with regard to that object are necessary. In my opinion a strong case can be made for taking the intentions of designers/makers as crucial in this respect. Without going into details, the basic argument revolves around a crucial difference between the notions of creating (that is, designing and making) and using technical artefacts. The creation of a technical artefact, whether in the sense of a new instance of an already existing kind or the first instance of a new technical artefact kind, has ontological significance; new objects are set into the world. With use this is generally not the case. When somebody uses a screwdriver to drive screws, no new technical artefact is created. Limiting cases of the creation of technical artefacts may occur in situations of *creative* use of natural objects [for example, shells may become technical objects (drinking cups) by creative use] or of already existing technical artefacts (using a knife as a screwdriver). In those cases creativity is restricted to attributing new functions to existing objects; no new physical objects are created.

In the following I will briefly discuss a theory that, in line with the above position, takes the mental states (intentions) of the designer-maker of a technical artefact to be constitutive for being a technical artefact of a particular kind. This metaphysical (ontological) theory of artefact kinds, put forward by Thomasson (2003, 2007) is very much in line with our claim that they have a dual nature.[1] She stresses that the intentions of

[1] For a brief survey of the debate about the ontological status of technical artefact kinds and relevant references, see Thomasson (2007) and Soavi (2009).

the humans making an object are constitutive for that object being an artefact of a certain kind. However, it is not simply the intentions of the makers that matter; the intentions of the makers have to be successfully realised, which brings in the physical structure of the artefact involved. This means that both intentions and physical structure are constitutive for being an artefact of a certain kind.

According to Thomasson, artefact kinds are different from natural kinds but no less real. They are different from natural kinds because 'the metaphysical natures of artefactual kinds are *constituted by* the concepts and intentions of makers, a feature that sets them crucially apart from natural kinds' (Thomasson, 2007, p. 53). She rejects the idea that the nature of artefact kinds is determined by mind-independent properties 'such as qualitative make-up, proper function, and historically proper placement' (Thomasson, 2007, p. 53), a position defended by Elder (2007). Artefact kinds have no 'internal essences' shared by all the members of the artefact kind; instead what determines membership of the artefact kind is that they are things intentionally made, more specifically that they are made with the intention to create something of that kind (for example, for something to be a chair it must have been made with the intention to be a chair). This means that artificial concepts exhibit self-referentiality. So, the sort of properties that ground the reference of artefact kind terms is intentional; whether something is a member of an artefact kind, as opposed to, for instance, a physical kind is determined by intentional properties (its intentional history).

More can be said about the intentions that are relevant for making an instance of an artefact kind K. When creating an artefact the maker's intention cannot always be described or made transparent in terms of making a new item of an already existing artefact kind K. That would exclude the possibility of making an instance of a new artefact kind. Moreover, just pointing at instances of an artefact kind and saying that one is making one of these will not do since it is not clear what features of these instances are relevant for being a member of the kind K. This means that the intentions of the maker should at least include what she calls a substantively correct concept of what a K is (Thomasson, 2007, p. 59):

> the relevant sort of intention to make a thing of artifactual kind K must thus involve a substantive (and substantively correct) concept of what a K is, including an understanding of what sorts of properties are K-relevant and an intention to realize many of them in the object created [. . .] [F]or a member of any essentially artifactual kind K to be created, it is also necessary that that intention be at least largely successfully realized.

When making an artefact, grand intentions, even when based on a substantively correct concept, are not sufficient; they have to be executed largely successfully, that is, embodied successfully to a large extent in matter.

The discussion above means that when somebody is genuinely making an instance of the artefact kind K, (s)he must have a largely correct idea of what it means to be a K, which implies that there is some inherent vagueness in the concept of an artefact kind. The largely correct idea determines which features are relevant for being a member of the artefact kind K. This does not mean that the criteria for membership of K are fixed once and for all by the substantively correct concept of a K of the person who made the first instance of a K (and through that created the artefact kind K). That would go against the fact that artefact kinds 'are notoriously malleable and historical in nature' (Thomasson, 2007, p. 62). Artefact kinds are historical kinds in the double sense that they come into existence by specific historical events (involving intentions) and that the criteria for membership of an artefact kind may change in the course of time. This change in membership criteria over

time may occur because once a new artefact kind K has been introduced, subsequent makers of Ks only need to have a *largely* correct idea of a K.

Thomasson's theory is intended to cover artefacts in general. She leaves open the details of how it may be applied more specifically to technical artefacts. In the following I will present an elaboration of her theory for technical artefacts taking into account their structural and functional features. When we apply Thomasson's ideas to technical artefacts, we arrive at the following definition of being a member of a technical artefact kind K:

Definition of technical artefact kind. An object X is a member of the technical artefact kind K if X is the result of a largely successful execution of a largely correct substantive idea of a K-er.

At first sight, this definition does not refer to the function or physical structure of a technical artefact, which may seem strange since, as we have argued above, the function and physical structure determine the artefact kind to which an artefact belongs. Nevertheless it does, but to see how we have to unpack the notion of a largely correct substantive idea of a K-er for technical artefacts. Thomasson's conception of artefacts and artefact kinds leaves open the possibility that intended functional features may play a role in the largely correct substantive concept of an artefact kind K (Thomasson, 2007, p. 59) and may therefore partly determine the boundaries of an artefact kind K. With regard to technical artefact kinds, however, both intended function and structural (design) features are necessary ingredients of a largely correct substantive idea of being a K-er. To see why, suppose the substantive idea would only refer to functional features of a K-er. In that case it would hardly make sense to call such a substantive idea a correct idea of a K-er, since it would not specify any structural features of a K-er, and would therefore not be executable at all. Similarly, as we have argued before, a purely structural description of an object does not describe it as a technical artefact of a certain kind.[1] In the case of technical artefacts a largely correct substantive idea of an artefact kind has to contain functional and structural (design) features because (part of) the correctness of the idea resides in the fact that objects of that kind will be able to realise their functional features on the basis of their structural features.

A largely correct substantive idea of an artefact kind must take account of the fact that, for technical artefacts, function and structure are intimately related. As a result, technical artefacts with the same (intended) function may belong to different artefact kinds since they involve different, largely correct, substantive ideas of an artefact (kind), that is, involve different designs and/or operational principles. Of course, this raises problems about identity conditions for largely correct substantive ideas and thus about identity conditions for kinds of technical artefacts. Here we touch again upon the inherent vagueness of the notion of artefact kind. Whether two technical artefacts are considered to belong to the same artefact kind or not may be highly context sensitive and therefore this problem cannot be solved in general. To illustrate the complexity of defining artefact kinds in engineering practice, consider the 'form, fit and function' principle.[2] Artefacts with the same form, fit and function are supposed to be interchangeable. With regard to very simple components, such as nuts and bolts, the form, fit and function principle usually implies that those

[1] Also the idea of largely successful execution would be problematic if the correct substantive idea contains only a structural description; such a description does not offer any criteria for which properties are relevant in making an artefact of that kind (this means that the structural descriptions should fix every conceivable minute detail of the physical object, also those details that are not relevant for performing the intended function).

[2] See, for instance, http://www.dmsms.org/file.jsp?storename=Form_Fit___Function_Fundamentals.pdf [date last accessed 7 April 2009].

interchangeable artefacts are taken to belong to the same artefact kind. However, for more complex components, this is not the case; even when two artefacts have the same form, fit and function, they may be based on different designs and therefore be considered to be instances of different artefact kinds.

On this interpretation of Thomasson's theory for technical artefacts, being a member of a technical artefact kind depends not only on the structural properties of the object involved, but also on its intentional history. It is therefore a mind-dependent feature of an object. According to Thomasson, these mind-dependent features are ontologically no less real than the structural features of technical artefacts. Therefore she claims that the ontological status of technical artefact kinds is in no way inferior to the ontological status of natural kinds. According to this line of thought, the desk on which I am writing this article is ontologically as real as the atoms of which the desk is composed.

5. Conclusion

Technical artefacts are the most tangible manifestation of technology. They are the outcome of human intelligence and physical work (labour). This characterisation already contains the kernel of their dual nature, which is reflected in the engineering structure–function conception of technical artefacts. Technical artefacts, as objects intentionally produced by human beings, are neither simply physical objects nor intentional/social objects. They differ from physical (natural) objects in that their function is a defining feature of what kind of objects they are. They differ from social objects, such as money, because these perform their function on the basis of collective intentionality. That is not the case for technical artefacts; they perform their function on the basis of their physical structures. The functions of technical artefacts, however, cannot be reduced to their physical properties, since they are also related to intentional human action. Because of this double grounding of technical functions in the physical as well as the intentional domain, technical artefacts have, epistemologically and ontologically, a dual nature.

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