# Technical Functions as Dispositions: a Critical Assessment

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**Abstract**

The paper argues that in order to understand the nature of technological knowledge (i.e., knowledge of technical artefacts as distinct from knowledge of natural objects) it is necessary to develop an epistemology of technical functions. This epistemology has to address the problem of the meaning of the notion of function. In the dominant interpretations, functions are considered to be dispositions, comparable to physical dispositions such as fragility and solubility. It is argued that this conception of functions is principally flawed. With the help of Carnap's analysis of dispositional terms it is shown that there is a fundamental difference between physical dispositional terms and functional dispositional terms. This difference concerns the issue of the normativity; with regard to functional dispositions, it makes sense to construct normative statements of a particular kind, with regard to physical dispositions it does not.

## Introduction: the dual nature of technological knowledge

Elsewhere we have argued for the dual ontological nature of technical artefacts (Kroes 1998). On the one hand, they are physical objects or processes, with a specific structure (set of properties), the behaviour of which is governed by the (causal) laws of physics. On the other hand, an essential aspect of any technical object is its function; think away from a technical object its function and what is left is just some kind of physical object. It is by virtue of its practical function that an object is a technical object. The function of technical objects, however, cannot be isolated from the context of intentional action (use). The function of an object, in the sense of being a means to an end, is grounded within that context. When we associate intentional action with the social world (in opposition to causal action with the physical world), the function can be said to be a social construction.[1] So, a technical artefact is at the same time a physical construction as well as a social construction: it has a dual ontological nature.

[1] By using the notion of social construction I am not implying that the context of intentional use of a technical artefact is inherently a social context. I leave that an open question.

This dual ontological nature has its counterpart at the level of technological knowledge. Technological knowledge also has two faces. On the one hand, it concerns the physical (or structural) properties of technical objects. Consider a car. It has all kinds of physical properties that are of crucial technical importance, such as its weight, the amount of fuel consumption per kilometre, its shape, its air resistance, its breaking power, the shape of its combustion chambers, the temperature and pressure in the combustion chamber during a combustion cycle etc. Knowledge of these physical properties, of how they hang together and of the physical/chemical processes taking place in, for instance, the engine of the car during operation, is part and parcel of standard technological knowledge of cars. On the other hand, technological knowledge also concerns the functional properties of objects. Apart from knowing that a certain object has a round shape, is made of steel etc., we also know that it is a steering wheel, i.e. that it performs a certain function in a car. Car designers, mechanics and users express at least part of their knowledge about technical objects, like a car, with the help of functional concepts. They claim for instance that object X has function Y, and assume that, just as a claim about a physical property, such a claim about object X may be true or false. Technological knowledge, we may conclude, not only consists of statements concerning the physical structure of technical artefacts, but also of statements concerning their functions.

From the point of view of engineering design, the idea that technological knowledge involves knowledge of structures as well as of functions is rather obvious. The engineering design process may be interpreted as a problem solving process in which a function is translated or transformed into a structure (Kroes 1996). The process usually starts by gathering knowledge about the desired function, and ends with a design that is a description or blue print of a physical object, system or process that realises the desired function. Various techniques are used by engineers to solve design problems. Some of these clearly illustrate the dual nature of technological knowledge, for instance, the techniques known as structural and functional decomposition of technical objects. In a structural decomposition, an object is decomposed in terms of the physical parts from which it is made or built. In a functional decomposition the overall function of a technical object is decomposed into a number of sub-functions whose composite functionality is the same as the overall function of the object (e.g. Dym 1994, p. 135). Knowledge about how to decompose overall functions into sub-functions is just as well part and parcel of technological knowledge as knowledge about what kind of physical structure realises a certain function. Thus, engineering design requires knowledge of functions and of structures.

In spite of the obvious importance of knowledge of functions for engineers, technicians and users of technology, little attention has been given to this kind of knowledge in analyses of the nature of technological knowledge. In the standard text on technological knowledge, Vincenti's What engineers know and how they know it (1990), no systematic discussion of this kind of knowledge is to be found. Vincenti discusses six categories in his anatomy of design knowledge: (1)fundamental design concepts, (2) criteria and specifications, (3) theoretical tools, (4) quantitative data, (5)practical considerations, and (6) design instrumentalities. Remarkably, a special category for knowledge of functions is lacking. The category of fundamental design concepts appears to come most close to functional knowledge. It contains operational principles that explain how a device works, i.e. in the words of Polanyi "how its characteristic parts… fulfil their special function in combining to an overall operation which achieves the purpose" (Vincenti 1990. P. 208). Thus knowledge of fundamental design concepts involves knowledge of functions and purposes. In further discussing fundamental design concepts Vincenti remarks that operational principles provide "an important point of difference between technology and science" (p.209). But a systematic analysis of what kind of knowledge knowledge of functions is and how this type of knowledge is related to knowledge of physical properties of objects is missing. A discussion of these questions has also not been found in the category of theoretical tools. These are tools used by engineers to carry out their design tasks. Under this heading Vincenti discusses intellectual concepts, which provide the language for the structure of thinking in engineering. Here he refers among others to basic ideas from science. But clearly, functional concepts (not borrowed from science since they do not fit into the scientific conception of the world) are as important for thinking in engineering design as are scientific concepts. But Vincenti does not explicitly mention them.

The philosophical analysis of knowledge of functions and of the meaning of functional concepts is a rather neglected topic. Particularly this is the case for technical knowledge and technical functions.[2] This is not very surprising in the light of the strong influence of modern science, where the use of functional concepts is generally considered controversial. Within the philosophy of the physical sciences there is a strong tenet to reduce

[2] More generally, the philosophical analysis of the nature of technical artefacts and their functions is an almost non-existent field. Preston (1998, p. 215) makes the following observation: "The nature of artifacts generally, and the nature of their functions in particular, is taken to be so transparently obvious, however, that virtually nobody has bothered to examine it at any length." See also Dipert (1993, p. 8).

functional concepts to structural ones.[3] A notable exception is the use of functions in biology. This use has been a topic of intense research and debate among philosophers of science (biology), but this debate has not resulted in a generally accepted interpretation of the nature of biological functions.[4] Prima facie, however, there seems to be an important difference between the notions of technical and biological functions; the former implicitly refers to a context of intentional human action, whereas the latter does not.

Central issues with regard to knowledge of functions are:[5]
What does it mean to state that object X has function Y?;
What are the conditions of truth for statements like "Object X has function Y'?; and
How can the statement that object X has function Y be justified?
Bearing in mind the above remark about the difference between biological and technical functions, the answers to these questions may depend significantly on the kind of functions considered. Here, we are primarily interested in technical functions. A systematic treatment of these questions for technical functions is still missing. The conclusion to be drawn from the foregoing is that in order to understand the nature of technological knowledge, especially in comparison to scientific knowledge, these questions have to be addressed. In other words, it is necessary to develop an epistemology of technical functions as distinct from an epistemology of structures (we will come back to this point later on).

As a first step in that direction, we will examine below in detail the idea that technical functions are dispositions. We will start, however, with a brief discussion of some preliminary issues concerning structural and functional statements (descriptions).

**Similarities and dissimilarities between structural and functional statements**

There are striking similarities and dissimilarities between structural and functional statements and descriptions. In the first place, we take it to be an empirical fact about functional statements that many of the functional statements used in ordinary life, just as many of the structural statements,

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[3] For a brief discussion of eliminativism with regard to functions, see Bigelow & Pargetter (1987).
[4] See for instance Wright (1973), Cummins (1975), Boorse (1976) and more recently Bigelow&Pargetter (1987) and Preston (1998).
[5] Note that from a logical positivist's point of view the first and the last question coincide.

have an empirical content and, depending on the empirical circumstances, may be true or false. Thus, statements like “This is a steering wheel”, “This steering wheel weights 3 pounds”, “This is a spoon”, “This spoon is made of silver” etc. are empirical statements and may be true or false depending on the objects involved. What remains to be seen is whether the notion of truth (falsity), that is referred to in the two cases, is the same or not.

Secondly, there are at least two modes of attributing a function to an object. In the one, it is said that object X has function Y (this object has the function to write); in the other, that the function of X is Y, (the function of this object is to write). We will take these two modes of function attribution to be equivalent. Furthermore, we will assume that expressions such as ‘Object X is a pen’ implicitly attribute a function to the object X by either one of the above modes. The same modes of attribution occur with respect to structural properties. Again I will take the two expressions ‘X has structural property Y’, and ‘A structural property of X is Y’ to be equivalent. What remains to be analysed is whether there are any significant differences between attributing a function (a functional property) and a structural property to an object. In other words, does the term ‘has’ (‘is’) have the same meaning in the two cases? Related to this issue is the question in what sense functions can be considered to be properties of objects, and in what sense the two subclasses of functional and structural properties are different.

Apart from these superficial similarities between functional and structural statements and descriptions, there are also (prima facie) deep dissimilarities. One of the most conspicuous differences concerns evaluative (normative) issues. It makes perfectly sense to claim of an object X, e.g. a car, that it is a good or a bad car, which roughly means that it is fit or not fit for a certain function. However, to claim that an object X, e.g. an oxygen molecule, is a good or a bad oxygen molecule makes no sense at all, because an oxygen molecule as such lacks a (intrinsic) function. Given the statement ‘X has function Y’, the evaluative statement ‘X performs function Y well (badly)’ does not seem problematic at all. The same does not apply to the statement ‘X has structural property Y’. A functional description of an object leaves room for an evaluative (normative) perspective, whereas a structural description does not.

There is yet, at first sight, another important difference between a structural and a functional description of an object. A functional description is a ‘black box’ description; the object is characterised in terms of how a certain input is transformed into an output. The function of a television set, for instance, may be characterised as a device that transforms an electromagnetic signal into pictures. How the transformation of input into output is realised, what kind of physical machinery is inside the black box, stays in the dark. In other words, the functional description is opaque with regard to the physical constitution or structure of the object, that realises the function. This is related to the fact that the functional description is the result of viewing the object from the perspective of a context of use, i.e. from the perspective of means and ends. What matters primarily from this perspective is that some object, irrespectively of its constitution, can be used as a means to a certain end. In contrast, the structural description is transparent with regard to the physical content of the black box; compared to the functional description, the structural description is a 'white box' description: it describes all the physical properties of the things inside the black box.

Although the foregoing seems to indicate that there is a strong asymmetry between structural and functional descriptions of objects as regards the transparency/opacity of the descriptions, this is not really the case. All depends on the perspective chosen. Just as a functional description is opaque as regards to the physical structure that realises the function described, the structural description is opaque is regards the function performed by the physical structure described. A purely physical description of an object does not tell what its function is (e.g., that it is a car), nor does a chemical description of a substance tell anything about its medical function.[6] Thus, from a functional point of view, a structural description is also a black box description. The situation is in fact symmetric in the sense that each mode of description black boxes the other one.

A fundamental assumption underlying the above point is that the functional and structural descriptions are independent of each other in the following logical sense: it is not possible to deduce the function of an object from the (complete) physical description of that object, nor vice versa. In other words, the physical description does not already contain (implicitly) the functional description, nor conversely. This is a rather obvious assumption given the fact that in general a certain function can be physically realised in different ways and the fact that one and the same physical object may perform different functions (known as multiple realisability of functions and as the multi-functionality of objects). This logical independence raises the issue of how engineers in design practice are able to bridge the gap between a functional description of an object (the input of a design process) and a structural description as given in a design (the output of the design process).

[6] See Vincenti (1990, p. 209) and Kroes (1998). But see also Dipert (1993, p. 151) who maintains, on the contrary, that under certain circumstances "intentions from a creator's means-ends hierarchy are observable in the physical object itself."

Note that from the perspective of making technical artefacts there is no symmetry or equivalence between functional and structural descriptions. For making a technical artefact a structural description (in the form of a design) is necessary. The whole point of designing is precisely to produce, given the description of a required function, a description of a structure which adequately realises that function. No matter how fine-grained a functional description of a technical object may be, in the sense of a many-layered functional decomposition in which sub-functions are decomposed in sub-sub-functions etc., it remains a black box description. At some moment, functions (sub-functions etc.) have to be translated into structures before it is possible to make a physical object which realises the required function.

Finally, the ontological status of functional and structural properties appears to be rather different. Functions do not fit in very well with the ontology of the physical sciences. From a physical point of view, objects have no functions. In contrast to physical properties which are considered to be intrinsic to objects, i.e. to be possessed by those objects independent of anything else, in particular conscious observers, functions are generally considered to be extrinsic, i.e. to be ascribed to the object by users:

> The important thing to see at this point is that functions are never intrinsic to the physics of any phenomenon but are assigned from outside by conscious observers and users. *Functions, in short, are never intrinsic but are always observer relative* (emphasis by author) (Searle 1995, p. 14).

If indeed there is such a difference in the ontological status of functional and structural properties, then it is clear that there is a fundamental difference in the attribution of structural and functional properties in sentences such as 'X has property Y' and 'X has function Y' (see above). Nevertheless, just as the attribution of structural properties, the attribution of functional properties appears to have objective significance. As Searle remarks:

> The existence of observer-relative features of the world does not add any new material objects to reality, but it can add epistemically objective *features* to reality where the features in question exist relative to observers and users. It is, for example, an epistemically objective feature of this thing that it is a screwdriver, but that feature exists only relative to observers and users, and so the feature is ontologically subjective (Searle 1995, p. 10).

It is precisely this situation that calls for the development of an epistemology of functions. If the attribution of technical functions to objects is epistemically significant, i.e. adds to our knowledge of the world up and above our structural knowledge of the world, then there is a need to elaborate an epistemology of functions. There can be no doubt about the truth of the conditional clause: the practice of engineering, and more generally the practice of every day life, show that functional claims contain genuine knowledge about the world which is different from knowledge contained in structural claims.

Part of any epistemology of technical functions will be an analysis of the following question: What kind of properties are functional properties? We will now examine a possible answer to this question, namely the idea that functions are dispositional properties.

**Technical functions as dispositions**

The idea that technical functions are some kind of dispositional properties of objects plays an important role in discussions about the nature of functions (whether biological or artificial). Already in the pivotal article of Wright (1973) this idea turns up, although Wright does not explicitly use the term 'dispositional'. As is well known, Wright defines functions in the following way:

> The function of X is Z means
> (..) (a) X is there because it does Z,
> (b) Z is a consequence (or result) of X's being there. (Wright 1973, p. 161)

A problem with this definition occurs in situations when a function is never realised or when a device malfunctions. As an example Wright mentions the button on the dashboard of a car, which activates the windshield washer system, but which is never used or malfunctions. In these cases X never does Z. Nevertheless, Wright wants to maintain that the button has the function to activate the wind shield washer system. In order to allow these cases, Wright has to interpret condition (a) in the following way: "All that seems to be required is that X be able to do Z under the appropriate conditions…" (p. 158). This comes very close to interpreting functions in terms of dispositions. Of course, in the case of defective devices also condition (b) has to be reinterpreted, since then Z is not a consequence of X being there. In fact, Wright notes that in those cases condition (b) has to be dropped or altered in such a way that it can accommodate these cases.[7]

Cummins explicitly ties functions to dispositions:

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[7] For more details see Wright (1973, p. 167). The malfunctioning of devices presents a real challenge for most theories about functions, and is a recurrent theme in the literature on functions. It is related to the issue of normativity of functions; see below.

> Something may be capable of pumping even though it does not function as a pump (ever) and even though pumping is not its function. On the other hand, if something functions as a pump in a system s or if the function of something in a system s is to pump, then it must be capable of pumping in s. Thus, function-ascribing statements imply disposition statements; to attribute a function to something is, in part, to attribute a disposition to it (Cummin 1975, p. 757-8)

According to Cummins, to attribute a disposition to an object is to claim that the behaviour of the object exhibits under certain conditions a certain lawlike regularity. These dispositional regularities require an explanation in terms of structural features of the object involved. An explanation of a dispositional regularity shows "how manifestations of the dispositions are brought about given the requisite precipitating conditions" (p. 758). Cummings does not further analyse the notion of disposition; he briefly remarks that it might be useful to distinguish between dispositions and capacities and that some might think that functions are more related to capacities than to dispositions (p. 759-760).

More recently, Bigelow and Pargetter have defended a disposition theory of functions. They start their analysis of functions with the remark that the attribution of a function to an object implies reference to future events, effects or states of affairs. In their view, "the function of the nutcracker at time t is to break open nuts at time t', where t > t'" (Bigelow and Pargetter 1987, p. 181). Whenever the appropriate conditions will occur in the future, the nutcracker will exhibit its function through a certain type of behaviour. This starting point requires, according to them, a forward-looking theory of functions, in contrast with the so-called representational and etiological theories which are backward-looking (the former connects functions to prior representations, the latter to the prior history of an object (p. 189)). In order to construct functions in a forward-looking manner they suggest to treat them as dispositions. They consider a function to be a subjunctive property: "it specifies what will happen or what is likely to happen in the right circumstances, just as fragility is specified in terms of breaking or being likely to break in the right circumstances" (p. 190). They propose a propensity theory of functions, which they consider to be a special case of a truly dispositional theory of functions. Their theory is primarily aimed at explaining biological functions, but they claim that it applies to functions of artefacts as well (p. 194).[8] Just as Cummins, however, Bigelow and Pargetter fail to further analyse the notion of disposition (and of propensity).

Finally, Preston has presented a pluralist theory of functions in which the notion of disposition (capacity) plays a crucial role.[9] She argues that it is necessary to distinguish between two different kinds of functions, which she calls system functions and proper functions. System functions are based on current capacities/dispositions of objects in relation to their current encompassing system, regardless of how the objects acquired these capacities/dispositions, that is, how they got there. For example, a tire may perform the function of a swing, or a dustbin may perform the function of a chair. For performing these (accidental) functions the question of how these objects got the required capacities/dispositions is irrelevant; it is sufficient that they actually have these capacities/dispositions. For proper functions the situation is quite different. For these the question of how the object involved acquired the capacities/dispositions is of crucial importance. Proper functions refer to capacities/dispositions which the object has had in the past, but the effects of which contributed to the survival of these capacities/dispositions into the present. Thus, for proper functions the selection history of that function is important. For example, the proper function of the heart in humans is to pump blood, because the effects of this capacity/disposition of the heart contributed to the survival of humans. According to Preston there is a fundamental difference between the two types of functions, namely proper functions are normative, whereas system functions are not:

> …the notion of system function is […] resolutely nonjudgmental. Things either have a capacity/disposition or they do not; but on this view, there is no particular sense to be made of the claim that there are particular capacities/dispositions they ought to have, but are temporarily or permanently unable to exercise even under conditions that seem completely appropriate or normal. The main difference between system function and proper function is therefore that the latter is normative whereas the former is not (Preston 1998, p.224).

With regard to proper functions it makes sense to speak of malfunctioning, that is, to make normative statements. The reason is simple:

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[8] See Bigelow & Pargetter (1987) p. 193; they arrive at the following definition of a biological function (p. 194): “So a character or structure has a certain function when it has a propensity for selection in virtue of that character or structure’s having the relevant effects.”

[9] Preston appears to use the notions of disposition and of capacity indiscriminately; she often uses the expression “dispositions/capacities”.

"If you can say what a thing is supposed to do, then you can also say when it is failing to do something it is supposed to do, that is, malfunctioning." (p. 223). Although the notion of disposition (capacity) plays a prominent role in Preston's approach, an analysis of this notion itself is conspicuously absent.

For a critical assessment of these various suggestions to treat functions as dispositions, it is necessary to look deeper into the notion of a disposition.

**Functional dispositional terms versus physical dispositional terms**

The basic idea of the interpretation of functions in terms of dispositions, is that in statements like "Object X is a copying machine", a disposition is attributed to object X, just as in statements like "Object X is water soluble", or "Object X is fragile". According to Bigelow and Pargetter, in both cases subjunctive properties are attributed to X: they state "what will happen or what is likely to happen in the right circumstances". But prima facie, these two cases of disposition attribution look rather different. The notion of 'copying machine' denotes a function, but the notion of 'water soluble' or 'fragile' has no functional connotations at all: it is not the function of X to be water soluble or to be fragile. For this reason we will distinguish between functional dispositional terms and physical dispositional terms. The former refer to functional properties attributed to objects, the latter to physical (and thus, non-functional) properties. Using Carnap's well known analysis of physical dispositional terms, we will now further analyse the nature of functional dispositional terms.

In his *Testability and Meaning* Carnap observes that it is not possible to define physical dispositional terms (soluble, breakable, etc.) explicitly in observational terms (Carnap 1936). Nevertheless, he shows that these terms can be reduced to observational terms in the following manner. Let O(x) stand for "x is soluble in water", W(x,t) for "x is put in water at time t", and D(x,t) for "x dissolves in water at time t". Carnap assumes that W(x,t) and D(x,t) are observational terms. Now the dispositional term O(x) can not be defined as:

$$O(x) = W(x,t) \rightarrow D(x,t)$$

for this definition has to annoying consequence that any object never put into water is soluble. To avoid this difficulty, Carnap proposes to reduce dispositional terms to observational terms with the help of the following two so-called reduction sentences:

R1: $W(x,t) \rightarrow \{D(x,t) \rightarrow O(x)\}$

R2: $W(x,t) \rightarrow \{\neg D(x,t) \rightarrow \neg O(x)\}$

For any object X put into water at time t, these two reduction sentences together determine whether object X is soluble or not, depending on what happens at time t. R1 specifies sufficient conditions for attributing the dispositional property O to x, R2 for denying that object x has property O. And whenever an object X is not put into water at any time t, nothing can be said about whether X is soluble or not. So, the awkward consequence of the explicit definition, that such an object is by definition soluble, is avoided.

Note that fixing the meaning of dispositional terms with the help of reduction sentences has the rather unsatisfactory consequence that nothing can be said about whether a given lump of sugar is water soluble or not, when this lump of sugar is never put into water. This problem may be resolved by making an appeal to induction. Other lumps of sugar have de facto proven to be water soluble and from this it may be inferred that this lump of sugar is also water soluble. This means that the knowledge contained in the statement “This lump of sugar is water soluble” is basically of an inferential kind in contrast to the knowledge contained in for instance the statement “This lump of sugar is white”.

We will now explore whether Carnap’s analysis of physical dispositional terms is also applicable to functional dispositional terms. As an example we take the functional dispositional term ‘copying machine’. Let C(x) stand for “x is a copying machine”, O(x,t) for “x is installed according to instructions and operated according to the user’s manual”, and P(x,t) for “x produces copies at time t”. Before proceeding, we have to point to a first difficulty here. Apart from there being various kinds of copying machines (based, e.g., on different operating principles) there are also various brands of copying machines, each with their own installation instructions and their own user’s manual. There are no generic installation instructions and generic user’s manual corresponding to the generic term ‘copying machine’. The definition of O(x,t) nevertheless appears to refer to such generic procedures for copying machines. In fact, what is intended in the definition of O(x,t) is that the appropriate installation instructions and user’s manual for the object x under consideration are used; in other words, the object x comes with its own installation and user’s manual.

The explicit definition of the functional dispositional term C(x) runs as follows:

$$C(x) = O(x,t) \rightarrow P(x,t).$$

Analogous to the case of physical functional terms, it would have the awkward consequence that anything that is not installed according to its instructions or is not operated according to its user’s manual, would be a copying machine. So, let us try to analyse the meaning of C(x) with the help of reduction sentences:

R1’: $O(x,t) \rightarrow \{P(x,t) \rightarrow C(x)\}$

R2’: $O(x,t) \rightarrow \{\neg P(x,t) \rightarrow \neg C(x)\}$.

The question to be considered is whether this analysis of the meaning of C(x) covers all and only those objects or systems x we would be prepared to call copying machines? For various reasons, it turns out to be problematic.

R1’ pretends to specify a sufficient condition for something to be a copying machine. It says: “If x is installed and used in the way it is prescribed at a certain time t, then, if x produces copies, then x is a copying machine.”
Is this indeed a sufficient condition? Suppose some system y designed for performing function Y, which is in no way related to copying documents, produces as a by-product copies of an original document. Would we then call this system Y a copying machine? Almost any bureaucratic system, performing adequately its prescribed function, produces copies of documents as by-product of its activity; but it would seem strange to call the bureaucratic system itself a copying machine (or system). This example is just a variant of the much discussed issue of how to distinguish between accidental and proper effects of functions. This issue emerges not only in connection with biological functions but also in connection with technical functions. The function of the heart is to pump blood, but as a by-product of this activity it produces sound. When we construct the analogue of R1’ for the case of the heart beat and pumping blood, we would get something like:

(1) If a heart beats, then, if the heart pumps blood, its function is to pump blood.

But we could equally well construct the following analogue of R1’ for the case of the heart beat and making sound:

(2) If a heart beats, then, if the heart makes sound, its function is to make sound.

Obviously, R1’ is not a sufficient condition for the attribution of functions; it allows too many objects to be called copying machines. Any adequate theory of functions (biological or technical) must be able to discriminate between proper and accidental effects of functions. A theory that does not rule out the possibility that the function of the heart is to produce sound is clearly inadequate. So is a theory that allows the conclusion that a bureaucratic system is a copying system. Clearly, Carnap’s analysis of dispositional terms does not discriminate in any way between (1) and (2), even when we also take R2’ into consideration.

Comparison of R1 and R1’ brings to light an important difference between functional and physical dispositional terms. R1 says: “If x is put in water at time t, then, if x dissolves, x is soluble in water.” There seems to be nothing wrong with the attribution of the dispositional term soluble in water to x. R1 specifies sufficient conditions for this attribution. This is not the case for R1'. Some crucial information is missing to warrant the conclusion that x is a copying machine, information about whether the effects considered are accidental or not in relation to the function attributed.

Now let us turn to R2'. Analogous to R2, it is intended to specify a sufficient condition for not attributing a functional dispositional property to an object. It says: "If x is installed and used in the way it is prescribed at a certain time t, then, if x does not produce copies, then x is not copying machine." But just as R1' falls short off being an adequate counterpart for R1, so R2' does for R2. R2' does not lay down sufficient conditions. In case a copying machine malfunctions, because of, e.g., a paper jam or of a defective switch, it is still considered to be a copying machine. Malfunctioning does not deprive an object of its function: it is still a copying machine, but one out of order. Again a significant difference between functional and physical dispositional terms shows up. R2 does specify sufficient conditions for not attributing the dispositional property 'soluble' to an object. In this case it does not make any sense to appeal to a malfunctioning of x (of a lump of sugar). The reason is that malfunctioning is a normative concept that cannot be applied to physical dispositional terms.

From the foregoing we may conclude that Carnap's analysis of physical dispositional terms is fundamentally inadequate for functional dispositional terms. There are real, significant differences between these two types of dispositions. It is very misleading to suggest, as Cummins but also Bigelow and Pargetter explicitly do, that functions are dispositions of the same kind as dispositions like fragility and solubility.[10] If the interpretation of functions in terms of dispositions is to be of any value, it requires a conception of disposition which in some respects will be fundamentally different from physical dispositions. So far, advocates of interpretations of functions in terms of dispositions have failed to provide a corresponding adequate conception of dispositions.

## Concluding remarks: technical functions and normativity

Since normativity plays such an important role in distinguishing functional from physical dispositions, we will round off with two brief remarks about normativity and technical functions. First, it should be remarked that the attribution of a technical function to an object and the issue of whether an object performs it function well or not, appear to be related.

[10] See Cummins (1975, p. 758) and Bigelow & Pargetter (1987, p. 190).

The question is whether it is possible to distinguish neatly between the following two cases:

(1) “This is a car, but a bad one, i.e., it does not perform its intended function very well.”

and

(2) “This is not a car at all, i.e. it is a mistake to attribute the function of a car to this object.”

Is it possible to distinguish in a systematic and clear way between not having a function and malfunctioning (Preston 1998, p. 223)? In general, this seems rather problematic; at what moment does a well functioning car stop being a car when it is piece by piece taken apart? It appears that there will always be borderline cases for which it becomes a matter of arbitrary choice whether to claim that the object malfunctions or does not (any longer) have a certain function.

Secondly, according to Preston, the issue of normativity only arises with regard to proper functions, not with regard to system functions (see quotation in section 3). In her opinion, objects with proper functions may malfunction, but not objects with system functions, since the latter lack “machinery for specifying malfunctions in contradistinction to mere lack of function” (p. 224). Proper functions have built their standard of well functioning more or less into them, in contrast to system functions such as the tire used as a swing or an orange crate used as a chair. In her opinion, it makes no sense to claim that a tire ought to have the right capacities/dispositions to function as a swing etc. But even for systems functions the use of normative statements seem appropriate: it does make sense to say that this tire functions well or bad as a swing, or that this orange crate functions bad as a chair (e.g., because its use as a chair is dangerous).[11] Even if an object performs a function by accident, the performance of this function may be normatively evaluated. Functions, whether proper or system functions, appear to be inherently normative.

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[11] Here the question arises whether the following two statements:
“This tire functions well or bad *as* a swing”, and
“This tire *is* a good or bad swing”
have the same meaning or not. We will leave this question aside.

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