Theories of Technical Functions: Function Ascriptions vs. Function Assignments, Part 2

Peter Kroes[1]

Introduction

Starting from the observation that both philosophers and engineers face troubles when trying to account for the role of human intentions in regard to technical functions, I introduced in Part 1 of this article two important distinctions intended to clarify this role. The first one is the distinction between function ascriptions and function assignments.[2] A function ascription is an epistemic act; it expresses the (justified) belief that an object has a particular function (e.g., "This thing is for driving screws"). Being an epistemic act, a function ascription might be either true or false. Function assignments, by contrast, are performative in nature; they occur when functions are imposed on objects. For instance, when somebody uses (or tries to use) an object for driving screws, that object is (implicitly or explicitly) assigned the function of driving screws. Function assignments may be successful or not. Second, I made a distinction between epistemic and ontological theories of technical functions and have analyzed the general form of these theories.

In this second part, I start with an analysis of the role of function assignments in epistemic and ontological theories of technical functions. I argue that the (epistemic or ontological) mind dependency of technical functions is grounded in function assignments. Finally, using how functions are conceived in engineering practice as a basis, I present in rough outline an epistemic and ontological theory of technical functions that proposes their hybrid (dual) nature, recognizing that technical functions are intimately related to physical features, as well as human intentions.

Function Assignments in Epistemic and Ontological Theories of Function

As emphasized in Part 1, function ascriptions are not to be confused with function assignments. Whereas the latter might figure in theories of functions, whether epistemic or ontological, the former cannot. As far as epistemic theories of function are concerned, the reason that function ascriptions cannot play a role therein is simply

1 Department of Philosophy, Faculty of Technology, Policy and Management, Delft University of Technology, The Netherlands; email address: p.a.kroes@tudelft.nl. The first part of this paper appeared in the previous issue of *Design Issues*.

2 Sven Ove Hansson, "Defining Technical Function," *Studies in History and Philosophy of Science* 37 (2006).

that reference to function ascriptions would make those theories circular. Epistemic theories of functions are intended to explicate what it means to ascribe (in the descriptive sense) functional properties to objects (i.e., to explicate function ascriptions). Any reference to function ascriptions in ontological theories of functions would be problematic because it would imply that epistemic claims about functional properties of objects play a significant role in the ontological status of those functional properties. This implication runs counter to the idea that within an epistemic context the direction of fit is from our beliefs to the world, and not the other way around.

Contrary to function ascriptions, function assignments might figure in epistemic and ontological theories of function. Just as performative intentional acts may be taken to have ontological (and epistemic) implications for the social world (e.g., the signing of documents may create a new social entity, such as a firm), performative intentional acts such as function assignments might play a role in creating new technical artifacts. This is something that technical artifacts may be assumed to have in common with social objects. This idea leads to mind-dependent theories of function as defended by Searle[3] or Thomasson.[4] According to Searle, for instance, an object is a screwdriver "only because people use it as (or made it for the purpose of, or regard it as) a screwdriver,"[5]—in other words, because people assign it the function of screwdriver. In Searle's theory, therefore, function assignment has ontological significance because it may turn an object into a screwdriver. He also maintains that "it is a matter of objectively ascertainable fact that it is a screwdriver."[6] Here, Searle is making an epistemic function ascription claim. Although Searle does not work out an epistemic theory of function ascription in any detail, such a theory must allow, in his opinion, the epistemic claim that some object is, as a matter of objectively ascertainable fact, a screwdriver. Clearly, in such an epistemic theory, function assignments have to play a crucial role.

Of course, not just any function assignment will do, and so conditions under which function assignments might have epistemic and ontological significance have to be imposed. Spelling out these conditions is precisely what mind-dependent epistemic and ontological theories of technical functions ought to do. It is in this respect that Searle's mind-dependent theory of functions leaves a lot to be desired. He does not make clear, for instance, why in a particular context the successful assignment of the function of a screwdriver to a coin does not turn that coin into a screwdriver.[7] I do not try to analyze these conditions here; the following examples suffice to illustrate that this matter is rather intricate. I might try to use my telephone as a stapler and by this assign it the function of a stapler. It is an example of an unsuccessful function assignment, and we would not like such function assignments to support epistemic or ontological claims that my telephone has the function of or is a

3 John Searle, *The Construction of Social Reality* (London: Penguin Books, 1995).

4 Amie L. Thomasson, "Realism and Human Kinds," *Philosophy and Phenomenological Research* 67, no. 3 (2003): 580–609, and Amie L. Thomasson, "Artifacts and Human Concepts," in *Creations of the Mind: Essays on Artifacts and Their Representations*, ed. Stephen Laurence and Eric Margolis (Oxford: Oxford University Press, 2007): 52–73. Pieter Vermaas and Wybo Houkes ("Technical Functions: A Drawbridge between the Intentional and Structural Natures of Technical Artefacts," *Studies in History and Philosophy of Science* 37, no. 1 (2006): 5–18) present their ICE-theory of technical functions also as a mind-dependent theory of function ascription. They claim that the mind dependency is a consequence of their I-condition. Whether one interprets the ICE-theory as an epistemic or ontological theory, this I-condition does not imply that technical functions are mind dependent because the I-condition describes capacity and contribution beliefs about the object to which the function is ascribed. These epistemic beliefs, however, cannot be the foundation of the mind dependency of technical functions for the reasons given. One might save the mind dependency of technical functions in the ICE-theory by assuming that function assignment takes place during the selection of an object for its capacity to φ (see condition E).

5 Searle, *The Construction of Social Reality*, p. 10.

6 *Ibidem.*

7 P. Kroes, "Screwdriver Philosophy; Searle's Analysis of Technical Functions," *Techné* 6, no. 3 (2003): 22–35.

stapler. This response suggests that success is a necessary condition for function assignments to have epistemic or ontological impact. But now consider the case in which I turn on my television set to watch a certain program, but it does not work because the on/off switch is broken. In the act of turning it on, I implicitly assign the object involved the function of producing television images. However, as in the case of trying to use my telephone as a stapler, the function assignment is not successful. Nevertheless, the object involved is a television set, although a malfunctioning one. How is this possible if success is taken to be a necessary condition for function assignments to have epistemic and ontological significance? Moreover, success cannot be a sufficient condition for function assignments to have epistemic and ontological significance. Consider again the example of the use of a coin as a screwdriver. In a certain situation I might successfully assign a coin the function of a screwdriver. However, such a successful function assignment does not have ontological significance in the sense that it turns the coin into a screwdriver; this successful function assignment does not support the ontological claim that the coin is a screwdriver.

Whatever the details of the conditions to be imposed on function assignments to warrant their epistemic and ontological significance, it is clear that considerations about the pragmatic success of the function assignment have to enter the analysis at some point. However, considerations of an epistemic nature might also be relevant. The conditions to be imposed might refer to beliefs of the assigning agent—for instance, that (s)he knows or justifiably believes that the object to which the function is assigned has a particular physical capacity that realizes the assigned function, or that (s)he knows or justifiably believes that, if used in an appropriate way, that object will successfully realize the assigned function. In this way, epistemic considerations concerning the beliefs of the assigning agent can enter into epistemic and ontological theories of function. Note that this does not lead to circularity in the case of epistemic theories of functions because the epistemic beliefs of the *assigning* agent are different from the epistemic beliefs of the *ascribing* agent.

With the help of the notion of function assignment, the role of human intentions in mind-dependent theories of functions can now be explicated in the following way. According to these mind-dependent theories, whether epistemological or ontological, objects may be ascribed or have functional properties only in relation to human intentions or intentional activities. One form these human intentions or intentional activities might take is function assignment. Searle, for instance, speaks of the assignment of functions and McLaughlin about conferring, attributing, or ascribing functions to objects—all activities that are to be taken in a performative sense. According to such mind-dependent theories of functions, objects have or may be ascribed functional properties only in relation to function assignments by humans.

Note that in epistemic theories of function of the mind-dependent type, the agent that assigns a function has to be carefully distinguished from the agent that ascribes a function (i.e., the agent that makes an epistemic claim about an object's having a function).[8] Consider an archaeologist trying to figure out the function of an artifact of some tribe that, according to an ontological theory of functions, she takes to be determined by the intentions of the makers and users of the artifact. Here, the agent who ascribes the function is different from the agent who assigns the function. The archaeologist is engaged in an epistemic activity; she is interested in making (reliable) knowledge claims about the function of the artifact. The makers and users of the artifact may have had no epistemic interest but only pragmatic interests in the artifact, in the context of which they made function assignments.[9]

We have already observed that epistemic constraints on the agent assigning a function may enter into epistemic and ontological theories of functions. It is important to realize that the epistemic constraints involved in function assignments are, generally speaking, different from the epistemic constraints in function ascriptions. This difference may be illustrated with the help of the McLaughlin-style theory of functions discussed in Part 1. According to McLaughlin, "The truth conditions for artifact function ascriptions involve the beliefs and desires of agents, but they presuppose neither the truth of the beliefs nor the rationality of the desires."[10] Function ascription here is to be interpreted as function assignment. Without beliefs and desires of an assigning agent, there can be no function assignment, but, McLaughlin claims, from an ontological point of view it makes no difference at all whether these beliefs are true or the desires rational. This indifference to truth and rationality is what makes McLaughlin's ontological theory of functions so permissive. Let us assume that there are indeed no epistemic constraints at all to be imposed on the beliefs of an agent who assigns a function to an object. Whatever epistemic theory of function ascriptions one would like to add to complement this McLaughlin-style ontological theory, a similar assumption with regard to the epistemic beliefs of agents ascribing a function to that object would lead to the absurd result that any function ascription to that object would be as good as any other. In fact, the assumption that there are no constraints to be imposed on the beliefs of the ascribing agent leads to the conclusion that the development of epistemic theories of functions is a pointless undertaking.

Things become even more intricate when the same agent does the ascription and the assignment of a function. This situation occurs when someone successfully creates a first token of a new type of technical artifact (e.g., a corkscrew) and claims that the object she has made is indeed what she claims (a corkscrew). The creation of the new artifact involves a function assignment and the claim a function ascription. This situation may be interpreted as

8 See also Thomasson's discussion about the possibility of a realist epistemology with regard to artifact kinds; Thomasson, "Realism and Human Kinds." The fact that artifact kinds are taken to be mind-dependent (assigned) does not preclude the possibility of a realist epistemology with regard to artifact kinds: "The possibility of members of a group G making substantive discoveries about a certain kind presupposes that it exists and has its nature independently of G members' beliefs and concepts regarding its nature. That, however, does not require that it exist and have its nature independently of *everyone's* beliefs and concepts."

9 See also Pieter Vermaas and Wybo Houkes, "Technical Functions: A Drawbridge between the Intentional and Structural Natures of Technical Artefacts." They distinguish between different perspectives that agents may take with regard to a technical artifact, namely of a user, a designer, and an observer. They do not, however, relate their distinction of different perspectives to the distinction between function ascriptions in the descriptive and the performative sense.

10 Peter McLaughlin, *What Functions Explain: Functional Explanation and Self-Reproducing Systems* (Cambridge: Cambridge University Press, 2001), p. 60.

one in which the creator has a privileged epistemic status in the sense that her claim that the new object is a corkscrew cannot be false, given that her function assignment satisfies the conditions for ontological significance.[11] Thomasson's theory of artifact kinds allows the creator of a new artifact kind such a privileged epistemic status. This special status is then related to the fact that the agent involved has direct knowledge of her function assignment. However, depending on the ontological and epistemic theories of function (kinds) adopted, alternative interpretations of this situation are possible. The ontological theory of functions might, for instance, include conditions about the *social* assignment of function, in which case a lonely inventor cannot create, in an ontological sense, a token of a new artifact type. (This condition would exclude, for instance, the possibility of Robinson Crusoe's creating a new kind of technical artifact on his island.) This ontological view on function (kinds) may be reflected in epistemic theories of function (kinds), such that an agent cannot make a justified function ascription simply on the basis of her own function assignment.

In summary, in drawing up theories of technical functions, whether epistemological or ontological, it is crucial to take into account Hansson's distinction between descriptive and performative forms of function ascriptions. Exploiting Hansson's distinction, I have analyzed the role of descriptive function ascriptions and performative function ascriptions (function assignments) in epistemological and ontological theories of functions and have pointed out the role of function assignments in mind-dependent theories of functions.

Function Theories and Engineering Practice

So far, I have analyzed the general form of epistemic and ontological theories of technical functions and have not committed myself to a particular type of theory. In this final section I do so by sketching in broad strokes a theory of technical functions and technical artifacts inspired by the way engineers conceive of and describe technical artifacts. According to this theory, the functional properties of technical artifacts are ontologically related to human intentions (function assignments) and to their physical properties (capacities). Epistemologically, it is a theory of function ascriptions that refers to justified beliefs about function assignments and about physical properties.

When we analyze in detail the way technical artifacts are represented or described in engineering practice, the conclusion may be drawn that engineers use a *structure-function* conception of technical artifacts.[12] In a nutshell, this conception takes technical artifacts to be physical structures with functional properties. This conception is based on two modes of describing technical artifacts that are indispensable for engineering practice: namely, the functional and structural descriptions. The functional description, which

11 See, for instance, Thomasson's discussion of our epistemic relation to artifactual kinds in Thomasson, "Artifacts and Human Concepts."

12 Peter Kroes, "Coherence of Structural and Functional Descriptions of Technical Artefacts," *Studies in History and Philosophy of Science* 37, no. 1 (2006): 137–151.

usually plays an important role at the starting phase of a design project, describes a technical artifact as a black box with the desired input-output relation. Nothing is said about the contents of the black box (i.e., about the physical structure that is supposed to realize the function, which is the desired input-output relation). The structural description of a technical artifact focuses exclusively on the physical properties of what is inside the black box and disregards what the technical artifact as a whole or each of its components is for. This kind of description of a technical artifact plays an important role in the context of producing (making) technical artifacts. A design of a technical artifact has to contain a structural description of every relevant component of the artifact if that design is to function as a blueprint for its production; otherwise, producing it would be impossible. Any component described in a functional way is simply a black box, of which the content is yet unknown.

Many descriptions of technical artifacts in engineering practice have a hybrid character in the sense that structural and functional concepts are used side by side. Purely functional or structural descriptions are more the exception than the rule. They are incomplete descriptions of technical artifacts in the sense that purely functional ones ignore physical/material aspects, whereas structural ones ignore functional aspects. A structural description describes a technical artifact only inso-far as it is a physical object, whereas a functional description specifies the technical artifact only in terms of human expectations about what a technical artifact is supposed to do. It ignores how a technical artifact realizes its function. Structural and functional descriptions are complementary to each other. From an engineering point of view, a complete description of a technical artifact has to contain all its relevant functional *and* structural properties.

One important element from the engineers' structure-function conception of technical artifacts is still missing. So far, I have coupled the functional properties of technical artifacts exclusively to human intentions (expectations). However, the function of a technical artifact is also intimately related to its structural features, since not just any physical construction can perform any function; that is what engineering design is all about: finding the right "filling" for the functionally defined black box. This intimate relationship is expressed by saying that the physical structure of a technical artifact performs or realizes its technical function. The physical structures of modern engineered technical artifacts are not simply "enabling objects" that make particular function assignments by human beings possible; they are not "lying around" like stones in a brook that may be assigned the function of stepping stone by somebody crossing the brook. From an engineering point of view, the physical structures are much more than that: They are the physical realizations of designs, or the physical embodiments of the structural and functional properties of technical artifacts as defined in their designs.

These structural and functional properties together define the kind of technical artifact involved.

On the basis of the foregoing, technical functions (functional properties) may be considered to have a hybrid nature. On the one hand they are intimately related to physical properties and on the other to human intentions. This leads to a mind- dependent theory of technical functions, although not one in which functions are defined solely in terms of human intentions. Instead, technical functions have a "hybrid" nature because they are grounded in physical properties and human intentions. Taking into account the hybrid nature of technical functions in the engineers' structure-function conception of technical artifacts, we can claim that technical artifacts themselves have a hybrid, dual nature: They are objects with both physically and intentionally based properties.[13] Ontologically, this means that technical artifacts are constituted by their structural and functional properties (and the functional properties are not ontologically reducible to structural ones).[14]

This hybrid nature of technical functions may explain the difficulties engineers have in disambiguating and fixing the meaning of the notion of function, especially in relation to the notions of physical behavior of technical artifacts and the purpose of these artifacts. Rosenman and Gero, for instance, remark that engineering design involves concepts from "both the human sociocultural environment and the physical environment."[15] As we have seen, functions are usually represented by engineers in terms of input-output relations; there is, however, no agreement about whether functions correspond to properties of the content of the black box or to properties of the practice of intentional human action in which technical artifacts are embedded. The former interpretation ties it to physical properties (capacities) of the technical artifact, the latter to the ends pursued by human beings. Pahl & Beitz apply "the term *function* to the general input/output relationship of a system whose purpose is to perform a task,"[16] whereas Hubka and Eder interpret the notion of function in terms of internal processes taking place in a technical system.[17] According to Roozenburg & Eekels "the function of a system is the intended transformation of inputs into outputs."[18] Sometimes a distinction is made between two different kinds of function: one referring to actual behavior, the other to intended behavior.[19] Chandrasekaran and Josephson make a distinction between environment-centric and device-centric views on function, with the former tying functions to human purposes and the latter to physical properties.[20] This ambiguity in the notion of function appears closely connected to the fact that technical artifacts act as an interface between a social/intentional outer environment and a physical inner environment.[21]

Now, we can try molding the idea of the hybrid, dual nature of technical functions in the form of the general epistemic and ontological theories of functions discussed earlier.

13 Peter Kroes and Anthonie Meijers, "The Dual Nature of Technical Artefacts," *Studies in History and Philosophy of Science* 37 (2006): 1–4.

14 This leaves open the question of how the realization relation between functions and structures has to be construed ontologically. For a discussion of this problem, see A. W. M. Meijers, "The Relational Ontology of Technical Artefacts," in *The Empirical Turn in the Philosophy of Technology Research in Philosophy and Technology, Vol 20 (Series Editor Carl Mitcham)*, ed. P. A. Kroes and Meijers A. W. M. (Amsterdam: JAI/ Elsevier, 2001): 81–96, and Wybo Houkes and Anthony Meijers, "The Ontology of Artefacts: The Hard Problem," *Studies in History and Philosophy of Science* 37, no. 1 (2006): 118–131.

15 M.A. Rosenman and J.S. Gero, "The What, the How, and the Why in Design," *Applied artificial intelligence* 8 (1994): 199–218.

16 G. Pahl and W. Beitz, *Engineering Design: A Systematic Approach* (London: Springer Verlag, 1996), p. 31.

17 Vladimir Hubka and W. Ernst Eder, *Design Science; Introduction to the Needs, Scope, and Organization of Engineering Design Knowledge* (London: Springer, 1996).

18 N.F.M. Roozenburg and J. Eekels, *Product Design: Fundamentals and Methods* (New York: John Wiley & Sons, 1995), p. 96.

19 For various definitions of functions within engineering contexts, see Balakrishnan Chandrasekaran, "Representing Function: Relating Functional Representation and Functional Modelling Streams," *Artificial Intelligence for Engineering Design, Analysis, and Manufacturing* 19 (2005): 65–74.

20 Balakrishnan Chandrasekaran and John R. Josephson, "Function in Device Representation," *Engineering with Computers* 16, no. 3–4 (2000): 162–177.

21 Herbert A. Simon, *The Sciences of the Artificial*, 3rd ed. ed. (Cambridge, MA: MIT Press, 1996 (1969)).

For ontological theories of function (kind) to do justice to the hybrid nature of functional properties, they have to ontologically relate those properties to function assignments (human intentions) and physical features. Conditions have to be imposed on function assignments because not every function assignment has ontological significance. As the example of the coin used as a screwdriver shows, for ontological theories of function kind, simply requiring that the function assignment be successful (which implicitly brings into play physical capacities) or that the object involved has the appropriate physical capacities is not sufficient. The example of the broken television set illustrates that this requirement also is not necessary. For epistemic theories of function (function kind), the hybrid nature conception of functions implies that justified function (function kind) ascriptions to an object X are to be based on justified beliefs about function assignments to X and about its physical features. For instance, the justified function kind ascription of being a screwdriver to an object X ("X is a screwdriver") may be explicated in terms of justified beliefs about the assignment, by an individual or a social group, of the function of driving screws to X and justified beliefs about X having the appropriate physical properties. Similar to the ontological theory, the epistemic theory of function kind ascriptions has to incorporate the conditions to be imposed on function assignments and physical properties that make it possible to distinguish between function assignments that support the corresponding function kind ascription to the object and function assignments that do not.

Conclusion

What I have presented here is only an outline of a theory of technical functions; the hard problem of spelling out the relevant conditions to be imposed on function assignments and physical properties remains to be solved. Whatever the precise details of these conditions, however, it is clear that function assignments play a pivotal role in theories of function that do justice to the hybrid nature of technical functions and technical artifacts. That, finally, may explain why it is so difficult to formally represent technical functions. Because of the ever-increasing complexity of the technical artifacts and systems designed, made, and maintained by engineers, there is a growing need for formal representations of functions. These formal representations are intended to be used not only in data bases for archival and retrieval purposes but also in computer-aided design (CAD) tools. In comparison to the formal representation of the physical/structural properties of technical artifacts, the formal representation of their functional properties turns out to be much more difficult. In the hybrid nature account of technical functions, the problem with functional properties is that they are grounded only in part in the physical/structural properties of technical artifacts; they also are grounded in function assignments (i.e., in human intentions).

This aspect of functional properties does not lend itself easily to the engineers' desire for formalization. It may be that the formalization of the functional properties of components, "deeply hidden in the inside" of technical artifacts, may be easier to accomplish because the intentions of designers and users related to function assignments may be cloaked or sidestepped to a large extent.[22] Mathematically representable input-output relations and physical characteristics of the technical artifact may from a practical point of view be enough to formally characterize those technical functions. However, the more we move in the direction of technical artifacts as a complex whole, the more the functions of technical artifacts become tied in with human intentions involved in function assignments. Formal representations of these technical functions may have to await a formal treatment of function assignments, if the latter is possible at all.

22 See Pieter Vermaas and Wybo Houkes, "Technical Functions: A Drawbridge between the Intentional and Structural Natures of Technical Artefacts." and William H. Wood, "Computational Representations of Functions in Engineering Design," in *Handbook of Philosophy of Technology and Engineering Sciences*, ed. Anthonie Meijers (Elsevier, 2009): 543–564. Even in these cases intentions cannot be eliminated completely; for instance, a chassis for fixing component parts cannot be formalized into some kind of physical potential barrier without a loss of meaning.