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The topic

There are two kinds of evolving, developing, and functionally organized entities in our world: biological organisms and technical artifacts. At a somewhat higher level, the parallel goes on with ecosystems and socio-technical systems. It is not astonishing, then, to find in the history of philosophy, but also in biology and in technology, many attempts to use entities of one kind as a model or explanation of the other. The transfer goes in both directions – cf. the machine metaphor for biological organisms and the evolutionary account of technological development. More than such controversial transfers, the comparison of organisms and technical artifacts with respect to special problems turned out to be fruitful in gaining a better understanding of organisms and artifacts. For example, teleological (teleonomic) behavior was described as a matter of self-regulation for both domains; symbolic processes were analyzed for both kinds of entities at the very beginning of thinking about artificial intelligence. More recently, advantage could be taken from such a comparison with respect to concepts of biological and technological functionality. During the last years the topic is vividly discussed in literature.

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Abstracts

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Conceptual conservatism: the case of normative functions

Most of us have the intuition that the parts of living things are "supposed to" fulfill certain functional tasks. Why are we moved to theorize about our concept of normative functions? My answer is this: because we are conceptual conservatives regarding the concept 'purpose.' Conceptual conservatives are committed to preserving or otherwise "saving" concepts that strike us as especially important, including our concept 'purpose' as it applies to organisms. And yet, insofar as the genealogy of our concept of normative functions traces to a largely theological worldview we now regard as false or unpromising, and insofar as we are psychologically constituted to apply this concept with undue generosity, we ought to relinquish the orientation of the conceptual conservative with respect to normative functions on the grounds that it diminishes rather than facilitates the growth of human knowledge. This casts doubt upon the main theories of functions in the philosophical literature, except for the theory of systemic functions which eschews the alleged normative dimension of biological purposes. There is, moreover, nothing parochial about 'purpose,' in which case we can conclude more generally that we ought to relinquish conceptual conservatism regarding a host of dubious concepts.

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The metaphysical grammar of "function" and the unification of artifactual and natural function

In this paper I want to express some reservations about the analysis of function we now have. There are of course several related difficulties, but the one that has most concerned me is what I will call the unification of artifactual and biological function. This is the thesis that both artifactual and biological function are real properties of things and that they are fundamentally the same notion, one reducible to the other, or derivative from a more fundamental notion.
My difficulties are epistemological, metaphysical, metaphilosophical and what I will call "grammatical." Addressing the unification problem will further require being very careful to notice shared features of artifactual and biological function but without begging questions. It will also help not just to investigate how we use the term 'function' and our own—rather feeble--intuitions about functional language, but also to investigate the origin of such expressions, including their etymology and original use in modern science.
The rough contour of the philosophical literature investigating function is this. In order to save the baby of biological function from the bathwater of teleology, a wealth of literature developed in the last two decades but especially in the last decade. Unfortunately, there has been an overwhelming preoccupation with biological function. This has a very good explanation, since biology has undergone a profound enrichment of its methods, adding a sophisticated genetic-evolutionary approach to classical biology and even to biochemistry. In contrast with literature of the 1920's through the 1960's, the heyday of classical philosophy of science, the philosophy of biology has become an increasingly conspicuous part of the philosophy of science. One would have thought that the older literature, on explanation, reduction and the nature of scientific theory (with chemistry and especially physics and astronomy as its paradigmatic examples) would have served perfectly well. Not so.

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The inherent normativity of functions in biology and technology

Traditionally theories of function have overwhelmingly been constructed for biological functions. The purpose of such theories was to save the notion of function for biology from the deadly embrace of teleology. Very roughly, function theories have come in two strains: etiological theories, which ascribe functions to components or traits on the basis of their causal history, usually their evolutionary history of being selected for, and systemic or causal-role theories, which ascribe functions on the basis of causal contributions to an encompassing system's 'behaviour'. Etiological theories have held the stage among philosophers, although it has been argued, recently with special force, that the function concept as used by biologists is the causal-role notion of function (Wouters 2003, Krohs 2004). An important element in the defence of the etiological theory is the claim that such theories are uniquely capable of accounting for the normativity of the notion of function, by which is meant our characterization of certain items or traits as malfunctioning, i.e. being physically incapable of doing what they are 'supposed to do'. The claim that etiological function theories are in fact able to account for the normativity of function has, however, also come under heavy attack recently (Davies 2001). Since the causal-role theory is unable to characterize an item as malfunctioning, the function concept must be seen to lack the inherent normativity that was always thought to characterize it. This is the position explicitly adopted by Davies. In the same vein Krohs (2004) and Boorse (2002) reconstruct evaluative judgements concerning functions (well functioning, poorly functioning, malfunctioning, dysfunctional) as purely descriptive ones of relative (quantitative) performance.
In my contribution I aim to evaluate the ensuing situation concerning the supposed normativity of the general notion of function. Since artefacts clearly can malfunction, it seems we are either forced to accept that there are two quite different notions of function, one inherently normative and the other not, or to retain a single non-normative notion of function and give an independent account of any normative judgements related to function, presumably on the basis of human intentionality. Elsewhere I have given an account of the normativity of artefact functions from a different angle (Franssen 2006), which will serve to clarify the issue. I will also use this account to critically assess Davies's explanation of why we have such strong intuitions that normative judgements concerning biological functions are in order.

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To pump blood and to transfer torque: functions in biology and engineering

In this paper I intend to contribute to the debate on the relation of artefactfunctions to biological phenomena. Namely, I compare the ways in which the biologists use their notion(s) of function with the ways in which the engineers use their notion(s). To this end, I match the four notions of biological function defined by A. Wouters against two complementary engineering methodologies for semi-formal models of device functions: Functional Representation and Functional Modelling. Besides eliciting the relevant similarities and differences, I show to what extent the conceptual structure of biological notions may be a guideline towards improving the engineering definitions and how the engineering models of device functionality may augment the biological understanding of natural function.

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The open border: Two cases of concept transfer from organisms to artefacts

In this paper, I examine the use of evolutionary approaches in three different domains that deal with technical artefacts – objects designed to serve practical purposes.
The possibility of transferring concepts, models and theories from the biological domain to the technological domain has often been studied. Typically, it has been analysed as a conflict between two basic notions: the neo-Darwinian natural selection of biology and the intentional actions that shape technology. Thus, we find attempts to minimize or even eliminate the role of intentions in technology, to pave the way for an application of evolutionary theory. Conversely, we find attempts to fend off this application by emphasising intentionality and the resulting conceptual gap between biology and technology. And finally, some approaches seek to close this alleged gap by cloaking the reference to intentions and natural selection or by stressing the metaphorical character of conceptual transfer.
I argue that the 'conflict model' that underlies most philosophical work oversimplifies the actual applications of evolutionary concepts and models to artefacts. The boundary between the biological and technological domains is not an iron curtain, but an open border. To establish this, I briefly look at three such applications – in archaeology, electronics, and the design of interfaces. In none of the three cases, the role of intentionality in technology is minimized; instead, it is bracketed to make room for evolutionary notions. In all cases, notions such as morphospace/design space and cladistic techniques are introduced to solve specific problems – in establishing artefact lineages, in design heuristics and in taxonomy respectively – but in none, an attempt is made to find counterparts of more evolutionary notions than those that serve this immediate purpose. Consequently, intentionality is not crowded out by evolutionary techniques, but its role is circumvented, supplemented, or even just redescribed.
The upshot of this discussion is a tentative, and hopefully sophisticated instrumentalism. It appears that, for some artefact domains, researchers are happy to let intention and selection co-exist in a variety of ways. Scientific practice thus proves far richer and messier than dreamt of in either evolutionist or intentionalist philosophy.

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Some ontological distinctions of functions of technical artefacts

Functionality is one of the key concepts for capturing technical artefacts and biological organisms. This article discusses mainly functionality of technical artefacts from the viewpoint of ontological engineering and engineering design. Although much research has been conducted on modelling of function in artificial intelligence and engineering design research, little is known concerning conceptualization behind the definitions and relationship among them. The authors have been involved in ontological consideration on physical systems, especially, function of technical artefacts based on a device-centred view. This paper firstly discusses our device-oriented definition of function. Next, we discuss a variety of functions of technical artefacts, which includes functions other than our device-centred definition, which are aspects for categorization of definitions of functions. For example, "system boundary" as an ontological distinction can characterize "environmental function" (which refers to those out of the system boundary such as user actions) and "system function" (which refers to behaviours in the system boundary). Such ontological distinctions help us clarify the meaning of function of artefacts and give us a clue of differences with functions of biological organisms.

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Technical artifacts, engineering practice and emergence

In recent times, the notion of emergence has become a topic of debate in engineering circles. Within an engineering context the challenge of emergent phenomena is not primarily of an intellectual, but of a practical nature, namely how to manipulate and control emergent phenomena. In engineering systems they may have disastrous effects (blackouts in electric energy supply systems are often taken to be emergent features of these systems), but they may also be beneficial (e.g. complex adaptive systems may be more robust to changing conditions in the environment).
Three issues related to the occurrence of emergent features in technological systems are of particular importance for engineering practice: 1) emergent causal powers, 2) the tension between emergent features and functional decomposition, and 3) the unexpectedness and/or unpredictability of emergent features. The reason why these issues are of particular importance is that they pose serious threats to what may be called the control paradigm of traditional engineering practice: under the conditions of operation and use led down in the design specifications the behavior of a technical system can be fully controlled by the control of the behavior of its constituent parts.
In order to get some grip on the topic of emergence in technical systems (different notions are being used and there is much confusion about terminology) and its implications for engineering practice, we address the question whether and in what sense functions of simple, stand-alone technical artifacts, such as everyday household utensils, may be regarded as emergent. We start off from the following general characterization of emergence: emergent features in (complex) systems are novel, qualitatively different features in comparison to the features of their parts, which cannot be reduced to the features of those parts and their relations. We also explore possible implications of various forms of ontological and epistemic emergence for the control paradigm. In particular we argue that the occurrence of weak forms of epistemically emergent features constitutes no threat for the control paradigm.

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The cost of modularity

Most modern technical artifacts and biological organisms have a modular organization: their parts and the processes they are involved in are organized in discrete groups. A main line of argument tries to explain the evolution of modularity as a process of adaptation. It starts with the observation that modularity opens up evolutionary pathways to increasingly complex systems and allows for quick radiation of biological taxa. The explanation then refers to a supposed selection for evolvability. I will show that the notion of a selection for evolvability, though it has explanatory value with respect to technical evolution, is not applicable to the realm of organisms. The arguments have to be rephrased in terms of selection for particular modules with particular capacities. Modularity and evolvability, then, may be results of the selection processes, but not themselves subjected to selection.
Despite its abundance, modularization has not overcome all integration and many evolutionary successful artifacts and organisms are either not modularized at all, or the modules show fuzzy borders: modularity comes in degrees. My aim is to show that the limited modularization of biological organisms poses a problem for the explanations of modularity in terms of adaptation. The key to an explanation of the persistence of nonmodularity is to be found in considering not only the benefit, but also the cost that modularity entails. Taking advantage of arguments concerning the costs and benefits of modular design in engineering, I will identify several classes of cost of biological modularity and propose the possible structure of an explanation of the evolutionary appearance of modularity that can simulateously account for the persistence of nonmodularity.

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Innovation and population

Creativity of all kinds, including creativity in the design of novel artefacts, is often explained by analogy with the explanation of organic adaptation by natural selection. It is hard to argue with the sentiment expressed by Daniel Dennett that innovation frequently proceeds by the application of a 'generate-and-test' algorithm, whereby a range of variants is compared against some set of requirements, the best ones being used as the source of further prototypes. One significant threat to the evolutionary view of innovation is not so much that this view distorts the true nature of the inventive process, but that it is too obviously the right view to offer much in the way of enlightenment to the student of creativity. One of the most persuasive responses to this sceptical charge has been to make use of conceptual resources from evolutionary developmental biology, which stress how the internal organisation and control of items undergoing selection makes a difference to their prospects for adaptive change. Here I try a different tack, focusing on the importance of 'population thinking' in the explanation of innovation. I argue that Mayr's conception of population thinking offers little help to the technological evolutionist, but that recent populational work by Boyd and Richerson points the way to novel questions that the student of technical change might pose, and also to some successful answers to those questions.

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The ontology of restored environments

Restoration ecology is the science aimed at recreating ecosystems which have been damaged or destroyed by anthropogenic or non-anthropogenic causes. Philosophical critics of restoration have argued that restored environments are not natural objects but instead are artifacts due to their anthropogenic origins. Underlying such claims is the assumption that while few things in the world are solely natural objects or artifacts, and that the domain marked by "nature" and "culture" exist on a continuum, natural objects are those things which are "re-latively free of human influence." Here I will take up directly the question of the ontology of restored environments. I will focus my attention on three answers to the philosophical critics of restoration by restoration ecologists: (1) historical fidelity, (2) succession, and (3) natural teleology. (1) To distinguish themselves from environmental mitigations nearly all restorationists argue that a properly restored environment must exhibit historical fidelity. That is to say, it must recreate a system that arguably existed at a site at a previous moment in history. I will argue that the criteria of historical fidelity does not respond to the metaphysical claim as it is constructed by the critics. Historical authenticity is either impossible in practice or conceptually incoherent. (2) Other restorationists argue that they can make systems which are more natural by restoring natural succession. Restorations that are so small that they cannot function without substantial human interference – such as the management of restored prairies and savannahs using controlled burning – are not real restorations because succession regimes are artificial rather than natural. A real restoration would restore a self-sustaining succession regime; projects which cannot restore succession are something other than restorations of nature because they are not really natural. I will argue that the restoration of succession is also practically impossible and conceptually confused. (3) Still other arguments by restorationists that their projects are natural appear to rest on a crude form of Aristotelian natural teleology. Given the ample reasons to reject such a view, is there then any description of restorations that would salvage them as natural objects? I will argue that there is, though this will require a redescription of the ontological distinction between natural objects and artifacts.

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How biological, cultural and intended functions combine

Prototypes of artefacts and organisms are clearly different: one is a non-living technical object (an engine or a car) and the other is a living being (a lion or an oak tree). Moreover, an artefact function and an organ function seem to have little in common since the first presupposes some intentional action whereas the second is a product of nature. These visible differences support the currently made distinctions about functions: natural or biological ones versus artefactual or cultural ones, or intended ones versus selected ones. I will argue however that no rigorous classification, and hence no scientific one, can be based on such distinctions. I will defend this claim by considering three cases – and focusing on the first one - where these customary distinctions are shown to be ineffective:
(a) when the artefactual mixes with the biological
(b) when the intended merges historically with the culturally established, be it selected or not
(c) when the selected and the intended intertwine in invention processes
There is a large domain of biological artefacts that possess functions which are simultaneously biological, cultural, and artefactual. I will examine what preliminary conclusions should be drawn from this fact with regards to our understanding of functions and functional explanations. I will argue that this offers a new perspective on what functions are. An examination of the two remaining cases will show that no sound basis can be found for any of the above mentioned current distinctions. Finally, I will contend that the shortcomings of these distinctions lie in the stress they put on the origin of functions, and I will give some hint on how functions might be characterized independently of their origins.

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Wholes, parts, and norms

There is a certain asymmetry in the ascription of functions to organic and technical phenomena. Organs and traits of organisms are ascribed functions, but organsims themselves are not – or at least not in the same sense. In the case of complex artifacts, both whole artifacts and their component parts are regularly ascribed functions. Yet the ascription of functions to component parts seems less arbitrary than to wholes. The purpose or function of an artifact, though served by and reflected in its material properties, is external to the artifact and depends crucially on the intentions of its designer or user and can change when this intention changes. The end to which an artifact is used can be changed without necessarily altering it physically. The apparent arbitrariness attached to the functions of whole artifacts does not seem to apply to the component parts. Whereas a hammer may have the function of driving nails or of squashing jelly beans, the handle of the hammer nonetheless retains its function in both cases: it remains basically a lever. In parts of systems the function seems to be materially embodied in the structure. In this paper I shall adress the question of whether the part-whole relations in functional systems determine what the parts are supposed to do and thus may be responsible for introducing normative considerations that change the character of the function ascriptions.

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Changing the mission of theories of teleology

Various accounts of the functions of objects, both biological and artefactual, seek to find one factor and pin all of 'the function of X' onto it. Often such theories succeed in many areas and shed light on function. But then the counterexample game begins, and clever exceptions lead to revisions, extensions, exceptions, or rejections of the functional account. Perhaps the problem lies in the mission of seeking 'the function' in the first place. Different questions about the function or behavior of a given object yield different answers, and there may be no single factor that can be called to ground 'the function' of an object which will explain all of its behavior and properties. This is not to give up on teleology, but it is to invite a more multifaceted approach to identifying and using functions. Emphasis on explanations may lead to a richer and more successful use of teleological functions.

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Proper function, selection, and fitness in comparative perspective

Proper (or etiological) functions have been traditionally defined in terms of a history of selection and reproduction for the functional performance. But the idea that natural selection picks out biological proper functions in this way has been progressively eroded so that it is now doubtful that natural selection has any such relationship to proper function. I shall show that parallel considerations apply in the case of cultural selection and proper function in material culture. An alternative in biology is to define proper function in terms of contributions to fitness. But, I shall argue, the phenomenon of biological fitness has no good analogue that plays the role in material culture with regard to reproduction that fitness does in biology. I conclude that definitions of proper function suitable for biology are unlikely to be of much use as models for a definition of proper function in material culture.

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Being for. A philosophical hypothesis about the psychological structure of functional knowledge

The subject matter of my paper is about how people perceive the difference between artefacts and biological entities. Therefore I will take into consideration the machinery that enables humans to approach artefacts as well as natural phenomena, in order to understand whether and how conceiving artefacts is indeed different from conceiving biological objects. This consists of the whole of the human cognitive apparatus, insofar it provides for the knowledge that is required to distinguish artefacts from natural entities, shall be under scrutiny. However I will restrict my investigation about the artefact/natural distinction to the intelligilbe field of cognition in which the intuitions of common sense can be directly compared with the empirical data of scientific observation. The field at stake is the area of cognitive psychology that inquires into (the origins of) concepts and human categorization. This region of cognitive studies can be said to theorize, on empirical bases, about the nature of functional knowledge. Apparently, the distinction between artefacts and biological things heavily relies on the capacity to understand the "functions" that characterize artefacts against natural items. I will argue that also on this ordinary ground the task is not easy.
In fact, grasping the function of an object, natural or artificial, is a rather complex psychological procedure of interpretation that presupposes a considerable amount of cognitive competences. Yet I will claim that understanding the function of an item cannot be the discriminating factor for

recognizing it as an artefact. The property of “being for” that one recognizes as the essential element that marks artefacts is indeed ascribed also to some natural entities.
In my paper, first, I will introduce the notion of “Design Stance”, consisting of the psychological attitude(s) by means of which people reason about an object in terms of its function(s). Then I will analyse the implications that are contained in the interpretation of a certain thing through the recognition of design and function in it. Finally I will disclose the hidden basic assumption that is taken by the identification of function and design in an object. In the conclusion I will draw a reflection about the interpretation of functions that are inspired by some Kantian ideas.

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Realism and artefact kinds

The aim of my research is to defend a realist approach to artefact kinds provided that artefact kinds are functional kinds. In the present work my aim is not that of working out a general theory of function attribution for artefacts.
One of the main reasons adopted for rejecting real artefact kinds is that artefacts kinds are functional kinds. A real kind of physical objects is a kind whose items must share a set of common physical features used in explaining their behaviour. A functional kind does not grant the existence of such a set because of the multiple realizability of functions. Hence, if artefact kinds are functional kinds, they may collect together objects with completely different physical structures.
I develop my argument in two different steps.
First, I draw from the main theories on functions three types of criteria for classification of artefacts into functional kinds: the selectionist criterion, the intentional-use criterion and the intetnional-production criterion. For each of this three types I sketch the ontological consequences of their adoption for artefacts classification into kinds. I put particular attention to the notions of copy and reproduction involved in some of the perspective analysed.
In the second part I suggest that the strategy for a defence of real kinds for artefacts is to individuate narrow kinds and to characterize function according to the following triple: (T) < Input-Output; System of Interaction; Object Structure > or <I-O, S-I, O-S>
Finally, I try to explain what’s the relation between kinds individuated according to the meaning of general artefact terms and those individuated according to my proposal.

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On changing your mind: taking also technical functions as objective predicates

Biological subsystems and technical artefacts have in common that they allow functional descriptions. Yet the meaning of these descriptions seems to differ. The functions of biological subsystems are typically taken as features these subsystems have objectively, whereas the functions of technical artefacts may be taken as subjective features of the artefacts that depend on the beliefs of agents. This difference is reflected by a difference between theories of biological and of technical functions: the first typically analyse biological functions as features that biological subsystems have as properties, whereas the latter may take technical functions as features agents ascribe to artefacts.
In my contribution I argue that this difference between functional descriptions of biological subsystems and technical artefacts is not a categorical one by proving that function theories that are phrased as theories about ascriptions of functions by agents can often be transposed into theories that take functions as properties. Firstly I introduce sufficient conditions for transposing function-ascription theories into theories about functions-as-properties. Then I consider intentional function theories that analyse functions of technical artefacts in terms of beliefs of agents and show that a number of them,

including the Houkes-Vermaas ICE-theory, satisfy these sufficient conditions and thus can be transposed into theories in which artefacts have functions as properties.

This argument opens the way to generalise function theories phrased for technical artefacts as theories about agentive function ascriptions, to overarching theories that, when applied to biology, are about biological subsystems having their functions as objective properties.