The bootstrapped artefact

The bootstrapped artefact: A collectivist account of technological ontology, functions, and normativity

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Abstract

Last year, this journal addressed the problem of technological artefacts, and through a series of articles aimed at tackling the 'dual nature of technical artefacts', posited an understanding of these as constituted by both a structural (physical) and a functional (intentional) component. This attempt to conceptualise artefacts established a series of important questions, concerning such aspects of material technologies as mechanisms, functions, human intentionality, and normativity. However, I believe that in establishing the 'dual nature' thesis, the authors within this issue focused too strongly on technological function. By positing function as the analytic axis of the 'dual nature' framework, the theorists did not sufficiently problematise what is ultimately a social phenomenon. Here I posit a complementary analytic approach to this problem; namely, I argue that by using the Strong Programme's performative theory of social institutions, we can better understand the nature of material technologies. Drawing particularly from Martin Kusch's work, I here argue that by conceptualising of artefacts as artificial kinds, we can better examine technological ontology, functions, and normativity. Ultimately, a Strong Programme approach, constructivist and collectivist in nature, offers a useful elaboration upon the important question raised by the 'dual nature' theorists.

Keywords: technological artefacts, dual nature, technological functions, normativity of artefacts, performative theory of social institutions

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1. Introduction

Technological artefacts have been examined from a range of perspectives within science and technology studies. The scholarship on technological artefacts has employed historical (Hughes, 1999), sociological (Latour, 1992), anthropological (Pfaffenberger, 1992), economic (Dosi, 1982), feminist (van Oost, 2003), labour process (Noble, 1999), cultural studies (Miller, 2001), psychological (Turkle, 1982), and philosophical (Feenberg, 2002) approaches in an attempt to comprehensively understand the nature of artefacts and their roles within society. These studies have demonstrated the complexity, heterogeneity, and dynamism that characterise technological artefacts, and have overwhelmingly captured the ubiquity of these objects in our societies.

Recently, this journal contributed to this body of scholarship by taking up as a subject of study the nature of technological artefacts. In a comprehensive issue dedicated to the topic, a series of authors posited a conceptual and analytic framework intended to address the so-called 'dual nature of technical artefacts' (Kroes & Meijers, 2006). The authors included in the special issue covered with impressive breadth a range of topics concerning technological artefacts, and collectively put forward a program of enquiry aimed at understanding the duality inherent in all these objects. Namely, these authors hope to identify, describe, and explicate both technological artefacts' physical structures and functional capabilities, which together constitute this 'dual nature'.

In this paper, I will argue that while this approach offers a great deal for our examination of technological artefacts, particularly by highlighting such issues as ontology, functions, normativity, and human intentionality, it too quickly elides important issues of artefact sociality. By deploying technological function as the analytic axis[i] within the 'dual nature' framework, the authors do not satisfactorily problematise function itself as a sociotechnical phenomenon embedded within a dense milieu of social practices. As such, I believe a re-examination of some central problems in the nature of technological artefacts is fruitful labour. Here I will re-examine the nature of technological function and its place within a broader framework for the analysis of technological artefacts by engaging with issues of artefact ontology and normativity. I hope to contribute to the work already begun by the 'dual nature' theorists and elaborate upon some of their crucial observations; specifically, I intend to demonstrate that a constructivist and collectivist understanding of technological function can further our understanding of technological artefacts.

Let us begin, then, by identifying some important characteristics of technological artefacts, so that we may establish the parameters within which this examination will take place. The several authors of the 'dual nature' issue argue that technological artefacts display four primary qualities. First, artefacts have an obdurate spatio-temporal materiality; that is, they exist physically in the world (Kroes & Meijers, 2006). Second, they are designed both in terms of their physical construction and their operative guidelines; that is, they are purposefully brought into existence (Kroes & Meijers, 2006; Vermaas, 2006). Thirdly, humans mobilise artefacts in order to carry out particular tasks: artefacts have functions (Kroes & Meijers 2006; Varmass & Houkes, 2006; Hansson, 2006; Houkes, 2006). Finally, artefacts have a normative component both in the sense that humans can use artefacts 'correctly' or 'incorrectly' and in the sense that specific examples of an artefact type can be

'good' or 'bad' (Franssen, 2006; Dancy, 2006). This fourfold characterisation serves to delimitate the field of interest, and satisfies our need for a clear identification of the issues under scrutiny.

As I will detail below, the authors of the 'dual nature' thesis broadly tend to argue that technological artefacts (as characterised by these four qualities) can be conceptualised as possessing a binary existence. First, artefacts have a designed physical structure with particular capacities; second, they have functional capability broadly associated with human intentionality. The linking bridge between the two is technological function (Vermaas & Houkes, 2006). As I will argue, function thus forms the reference point for considerations of artefact ontology, as it does for issues of normativity.

By not problematising technological function as a socially-constituted and dynamic phenomenon, and employing it as an explanatory concept for artefact ontology and normativity, the 'dual nature' theorists (perhaps unintentionally) reify function and engage with it as an immutable and essential quality. Consequently, the authors limit their own programme of description and explication; their conceptualisation of function poses a hurdle to their objective of analysing artefact ontology and normativity. I believe that an alternative approach, one that attempts to critically engage with the problem of artefacts through the Strong Programme's performative theory of social institutions (see Barnes, 1983; Bloor, 1997), can more effectively address these issues.

By using the work of Martin Kusch (1997, 1999), I believe we can examine technological artefacts as *artificial kinds* constituted through referential practice and formative intentional actions (Collins & Kusch, 1998). Through a sociophilosophical understanding of technology, we can come to develop a constructivist and collectivist framework for the analysis of artefact ontology, function, and normativity. In contrast with the 'dual nature' framework, I will argue that *artefact function is generated by rather than generative of usage*, and that we can analyse ontology, function, and normativity as collective practices made intelligible through self-referential social institutions.

This constructivist and collectivist understanding of artefacts allows the student of technology to symmetrically account for artefact functions, ontology, and normativity by examining the social processes that bring these into being. That is, unlike the 'dual nature' theorists, I intend to use Kusch's notion of artificial kinds to account for function, ontology, and normativity a products of the same social institutions, rather than mobilise function in order to explicate the remaining facets of artefacts.

My attempt to employ the Strong Programme within studies of technology is certainly not without precedent, as previous work has followed related strands within the sociology of scientific knowledge (SSK). Perhaps most notably, Pinch and Bijker (1984) mobilised the empirical programme of relativism in order to develop the 'social construction of technology' approach. My project here differs in two important senses: first, I am employing a separate component of SSK and second, I am interested not in the development of new technologies but instead on the nature of technological artefacts. MacKenzie (1996) also employed SSK in order to examine the manner in which knowledge about technologies and technological artefacts comes to be accepted on a wider scale. Although his concerns resonate closely with my own interests here, he focuses more closely upon knowledge of technological function rather than address issues of ontology and normativity, with which I engage in this text. Thus,

while my approach is situated in relation to other attempts to employ SSK to the study of technology, it is distinct both in its choice of framework and topic.

Below, I will detail the approach taken by the 'dual nature' theorists, focusing upon their conceptualisation of artefact ontology, function, and normativity. I will then proceed to describe the analytic and conceptual tools of the performative theory of social institutions by examining the concept of artificial kinds, and the nature of referential practice and formative intentional actions. Finally, I will employ these in an examination of a specific technology, the waiter's corkscrew, before moving on to draw some conclusions and implications of this work.

2. The 'dual natures' thesis

Let us review the principal theoretical propositions argued by the authors of the 'dual nature' issue. I should note that the issue does not provide an explicit, comprehensive theoretical programme free of analytic tensions; rather, it forwards a series of postulates and tentative theoretical frameworks. As such, this section is intended to consolidate the various strands of argumentation into as cohesive a framework as possible. I will address the duality of technological artefacts, technological functions, and normativity with the aim of summarising and synthesising the issue's literature as effectively as possible.

The 'dual nature' authors, as I hope to demonstrate below, mobilise the concept of proper functions in order to analyse issues of artefact ontology and normativity. While in principle the 'dual nature' of technological artefacts—that is, structural and functional—is not a flawed model, the authors' over-reliance upon technological function and structural limitation ultimately proves to be a hurdle rather than an aid. Without problematising and deconstructing the very phenomenon of technological function, any analysis of technological artefacts will draw limited conclusions about the nature of these objects and their place within social practices.

2a. Function(s) and ontology

First, let us address the duality of technological artefacts, the 'dual nature'. As Kroes and Meijers argue in their introduction to the issue, the analytic ethos of the collection is a commitment to conceptualising technological artefacts as constituted by two distinct, though inter-related and mutually-dependent natures. Technological artefacts are composed of first, a "designed physical structure" (Kroes and Meijer, 2006, p. 2) and second, "functions, which refer to human intentionality." (ibid, p. 2) Thus, the authors of the special issue begin their work from a dichotomisation of artefacts into "structural" and "intentional" components, by which Kroes and Meijers broadly mean physical and human-agentic components.

Consider the waiter's corkscrew. Let us employ this example to explore the nature of technological artefacts. This object has a physical component (it has materiality and mechanical capacities) and an intentional component (it is used to perform a particular task: removing corks from bottles).

Kroes and Meijers go on to recognise the difficulty of relating these two components and in some way identifying the links the bind artefacts' double existences. Approaches that focus on the structural component, often labelled "mechanistic approaches" (see de Ridder, 2006), do well in characterising the relationship between physical constitution and artefact function,

but ultimately elide the relationship between functions and mental states, which necessarily "form the core of the intentional conceptualisation" (Kroes and Meijers, 2006, p. 2) Conversely, theoretical approaches that focus heavy-handedly on the human intentionality component lack a connection to the so-called "physical substrate" (ibid, p. 2) of any one artefact. Clearly, some form of compromise is required to adequately link structural and intentional components and thus capture the full range of characteristics endemic to technological artefacts. The 'dual nature' theorists argue this link is to be found in technological functions.

Vermaas and Houkes suggest that by conceptualising of technological artefacts as binary entities, the 'dual nature' theorists are presented with a significant problem:

> the concept of a 'dual nature' immediately raises the question of how these natures connect. At the same time, the thesis provides a starting point for answering this question: the concept of technical functions provides the connection. (2006, p. 6)

As they argue, functions serve as the "drawbridge" (Vermaas & Houkes, 2006) between the structural and intentional components of technological artefacts, and thus resolve the considerable tension found in managing two discrete facets—physical and functional. Thus a waiter's corkscrew's structural and intentional components are linked by its function: "to open bottles by removing corks". Function allows the analyst to deconstruct or unify artefact ontology. A waiter's corkscrew can be understood to be ontologically distinct as a material entity or as a functional, operating entity used to perform a task.

To summarise: Artefacts have two distinct, though interrelated components: structural and intentional components. These two are linked by function, which can be used to link these two components or separate these two ontologies.

2b. Function(s) and proper function(s)

Vermaas and Houkes (2006) argue that technological functions constitute the 'drawbridge' between the structural and intentional components that characterise technological artefacts. Artefact function consist of:

> the role the artefact plays in a use plan for the artefact that is justified and communicated to prospective users. In our account, it makes no sense to ascribe technical functions to an object that is not, metaphorically speaking, embedded in a use plan. (Vermaas & Houkes, 2006, p. 4)

Use plans are behavioural scripts that individual users follow to accomplish specific ends. In addition to relying on end-goal achievement, use plans emphasise physical action and mechanical capacities: "a use plan of object x is a series of such actions in which manipulations of x are included as contributions to realising the given goal." (Vermaas & Houkes, 2006, p. 7) Thus a waiter's corkscrew has a function: "to open bottles by removing corks", which is linked with a particular use plan, consisting of the physical actions required to remove a cork from a bottle.

As functions are couched within use plans, not all forms of usage can be termed function; a synchronicity would have to be established with the behaviours congruous with the use plan. Scheele argues that functions can be categorised as proper functions, "*what the artefact is*

for" (Scheele, 2006, p. 25, emphasis original), or accidental functions, "any use that the artefact physically allows." (ibid, p. 25) Evaluating the nature of an artefact's proper function is a complicated business, which involves considerable examination of both the artefact's structure as well as its conventional usage. It is this second element of an artefact's proper function that Scheele chooses to examine; he notes that social context enters into an internal relationship with proper function in the sense that it cannot be elided when attempting to determine any artefact's proper function. Despite this, he ultimately argues that proper functions cannot be understood as products of collective social determination, as "[s]ocial considerations […] are at best *necessary*, but not *sufficient*" to determine function (Scheele, 2006, p. 25, emphasis original). Scheele argues that social considerations of usage fail to recognise the "physical features of artefacts, which are obviously not socially constructed" (ibid, p. 25) and provide a proper function that is grounded in the artefact's "objective properties, that is […] its physical properties and its causal history." (ibid, p. 28) Scheele does argue for a social contextualisation of function ascription, but subordinates sociality to 'objective physical properties', and although materiality is not a sufficient condition, it does receive analytic priority. A waiter's corkscrew has particular proper functions, which are embedded within a social context; however, these functions are ultimately more dependent upon material constitution, which overrides idiosyncratic usage, than social processes.

Similarly, Franssen argues that structure trumps intentionality, shifting the balance of functions ascription to the material component of the 'dual nature' thesis. He states, "[r]egarding the ascription of function, design often defeats performance." (Franssen, 2006, p. 51) and goes on to investigate the relationship between instrumental goals, materiality, and usage:

> what establishes the existence, for a person p, of an instrumental reason, conditional on p's having a particular goal, to use x, is the presence of certain physical capacities. (Franssen, 2006, p. 52)

Thus, mechanical construction dominates not only the ascription of function, but also instances of usage.

Finally, the 'dual nature' theorists examine the manner in which individuals learn about artefact functions and the manner in which they mobilise this knowledge, particularly in relation to an artefact's so-called 'proper' functions. Wybo Houkes (2006) argues that artefact function knowledge must be understood as consisting of two components: knowledge of a particular artefact as a specific kind of technological artefact and knowledge of how to operate that particular artefact. Thus to know that a waiter's corkscrew is a waiter's corkscrew is interlinked with knowledge of its proper function.

To summarise: Artefacts have proper functions, embedded within use plans, which determine the proper usage of the artefact. While social context is of considerable importance, it must ultimately be subordinated to physical structure when determining proper technological function.

2c. Function(s) and normativity

As I established above, our working definition of technological artefacts involves an inherent component of normativity, both in terms of artefact performance and artefact usage. Normativity, Franssen argues, consists of three components: the quality of an artefact token,

the success of artefact usage, and the validity of belief that a particular artefact can be used to accomplish a specific task (2006). The 'dual nature' theorists, when engaging with this particularly salient aspect of technological artefacts, again emphasise a functional conceptualisation of normativity.

As I discussed above, the 'dual nature' theorists argue that an artefact's proper function is couched both within a specific use plan as well as a set of physical properties that define that artefact's mechanical capabilities. This understanding of proper functions features prominently within the 'dual nature' theory of normativity. Franssen argues that when judging the quality of a particular token within an artefact kind, materiality dominates the process of evaluation:

> When we say that a particular violin is good, we express the fact that the violin has certain features and that these features, though not furnishing a reason or even a conclusive reason to do something in particular, are such that a positive rather than a negative attitude toward it is in order. (Franssen, 2006, p. 45)

Thus considerations of token evaluation within the 'dual nature' framework rely heavily on the artefact's physical and mechanical structure, and are contextualised within particular proper functions. Franssen does note, "the use of an artefact for the purpose it is designed for usually requires more […] than just the desire to realise the corresponding end." (Franssen, 2006, p. 47) and as such so do judgements of token quality. Artefact usage is embedded within use plans, which determine the necessary contextual requisites for successful operation:

> every artefact is imbedded in a use plan that specifies which operations of the artefact will lead to the end state that corresponds to the function of the artefact. A use plan tacitly or explicitly contains the circumstances that must obtain and the abilities the user must show for these operations to lead to the desired end state. (Franssen, 2006, p. 28)

For instance, waiter's corkscrews require trained operators in order to judge artefact quality and bottles upon which to perform the proper function and use plan. This is not merely an abstract point: wider considerations factor into the technological normativity question. However, we can see again that the emphasis is placed upon use plans, which themselves are representative of and deeply interlinked with proper functions.

Franssen concludes by noting that ultimately, proper function is crucial to normativity in the sense that artefacts can accomplish a range of tasks, but we judge only their proper function. Ascription will determine whether we can state an artefact *works* to do something or *is designed* to do something, and consequently whether we are justified in believing a particular artefact should operate in any single manner:

> mere function ascription to a particular artefact, that is, without bringing in the actual physical characteristics of a particular artefact, matches the justification of the use of that artefact. (Franssen, 2006, p. 53)

If we believe we are justified in using a particular artefact for its proper function, we can then make normative judgements of its performance. Franssen here reifies proper function, even eliding physical characteristics, as the determinant and basis of normativity in technological

artefacts. Our belief that the entity understood to be a waiter's corkscrew is used properly when it is used to open wine bottles is enough to validate our normative judgements of its performance in opening wine bottles.

To summarise: Artefacts are normative in the sense that they can be used correctly or incorrectly and can be good or bad examples of a type of artefact. These judgements are linked to the artefact's proper function, although the ability of an artefact to achieve this function is not an exhaustive measure of its normative status.

2d. A different approach

I have attempted to demonstate that within the 'dual nature' framework, function operates as the axis of analysis, providing the basis for an understanding of artefact ontology, usage, and normativity as well as linking physical structure and individual human intentionality. This framework provides the analyst with a great deal of valuable theoretical tools, but by not deconstructing function itself as a social phenomenon, does not explore a deeply problematic issue. In virtue of what do technological artefact have function, and how do we continue to understand them as possessing particular functions?

I contend that by employing the Strong Programme's performative theory of social institutions, supplemented by Martin Kusch's notion of artificial kinds, we can begin to answer these questions. By utilising this theoretical framework, we can shift the emphasis from function to the social processes that make technological artefacts intelligible *as artefacts*, and the practices that engender function and normativity. We are able to critically address the very nature of function not as a basis for understanding ontology and normativity, but rather as a product of social practices.

Put simply, we can *symmetrically* analyse artefact function, ontology, and normativity as products of social processes. This is the most important fact of a Strong Programme approach, the ability to equally problematise these three characteristics of technological artefacts, and thus supplant an analysis focused heavily on function as a causal factor with one that seeks to equally account for function, ontology, and normativity through social processes.

3. Technological artefacts as artificial kinds

The performative theory of social institutions, situated within the Strong Programme in the sociology of scientific knowledge, initially addresses referential practice and concept mobilisation. Following this framework (specifically Barnes, 1983) and Kusch's elaborations upon it (1997), I argue that we can characterise referential activity as operating through three conceptual and analytic categories: natural, social, and artificial kind terms.

Natural kind (N-kind) terms are those that individuals employ in order to categorise entities through analysis of external empirical qualities (Barnes, 1983). That is, N-kind terms can be employed by reference to a set of empirically-verifiable characteristics; these qualities are perceptually collected and then cognitively compared, analogised, and matched to a stored pattern. For example, when attempting to identity a particular entity, I might empirically observe that this object has features such as a fine coat of fur, pointed ears, and long whiskers[ii]; by analytically comparing these features to a previously-identified and stored pattern, I can induce that the object is indeed a 'cat'. Note that the referent (the spatio-

temporal entity we refer to as a 'cat') exists entirely independently from the label we choose to attach to it. The animal would continue to exist if we were to suddenly decide to call it a 'monkey' or a 'table lamp'. Our choice of word to label the N-kind entity is ultimately irrelevant. The animal lives on. Because these objects exist "independently of the reference" (Kusch, 1997, p. 17), we can state that natural kind terms are *alter-referential*[iii] (Kusch, 1997).

Conversely, we may speak of social kind, or S-kind, terms. Unlike the N-kind term, an S-kind term can be applied with no consideration whatsoever of the object's empirical characteristics. That is, there may be no way of empirically identifying an S-kind term in the same manner that I identified the 'cat' above. Consider an S-kind term such as 'leadership': the leader of a group does not necessarily posses any distinctive empirical features about him/her that would allow an observer to distinguish his/her 'leadership'. Instead, the S-kind term is properly applied to an individual simply because it has previously been properly applied in this manner: an individual has 'leadership' of the group because he/she has previously been referred to as possessing 'leadership'. As soon as the constitutive members of the group cease referring to and thinking of this individual as possessing 'leadership', that very 'leadership' vanishes (Barnes, 1983, 1988). The referential activity, rather than drawing from existing and external empirical qualities, creates the referent it labels. When I talk about 'leadership' of a group, I am creating that 'leadership'[iv]. As the referent, the S-kind term, has no existence outside the referring practice, social kind terms are *self-referential* (Barnes 1983). We can also speak of S-kinds as *bootstraps*. As Barnes notes:

> whenever in a system of inductive inferences the products emerge tagged with patterns recognized earlier in the system the intervening inductions will be described as *bootstrapped*. (Barnes, 1983, p. 534, my emphasis)

Thus S-kind terms are bootstraps of referential practice.

In addition to these two polar opposites, Martin Kusch introduces a third category: artificial kind (A-kind) terms (1997). Artificial kind terms lead an existence between N-kind and S-kind terms; as such, they have both alter-referents and an ontological status entirely dependent on self-referential activity. Put a different way, while artificial kinds have empirical qualities that can be observed and analyzed (an alter-referent exists), their ontological status is the product of self-referential activity. Allow me to develop this point with greater detail.

Artefacts such as 'waiter's corkscrews' have alter-referents in the sense that the spatio-temporal entity has an existence outside referential practices. We can speak of specially shaped pieces of metal, wood, and plastic; we can identify broad prototypical examples of these entities; we can cease our referential talk and the piece of metal would continue to exist. The shaped piece of metal strictly as a spatio-temporal entity has an existence independent of social activity. However, the entity known as a 'waiter's corkscrew' is necessarily dependant on social activity for its ontological status. The spatio-temporal entity is only the artefact known as a 'waiter's corkscrew' insofar as a social process makes it so.

I should note at this point that while the performative theory of social institutions was initially developed to discuss *terms* and *concepts*, I am here discussing technological artefacts as *artificial kinds*, not *artificial kind terms*. That is, I am discussing entities rather than the nominative demarcations we use to distinguish between entities. While terms are of obvious

import to the study of artefacts in society, my interests lie elsewhere: with the actual entities themselves, and our conceptual understanding of artefacts *as artefacts*.

Artificial kinds are embedded within social practice. This social practice, as I will argue below, takes the form of a *social institution*[v]. Social institutions are social phenomena that display five qualities: they are conventional, self-referential, generative, collectively-constituted, and normative. I will expand upon this definition below; for now I will claim that social institutions constitute the productive systems that transform material entities into technological artefacts.

4. Reference and formative intentional actions

As I stated above, social processes convert spatio-temporal entities such as pieces of metal into technological artefacts such as 'waiter's corkscrews' These processes consist of two components: referential practice and formative intentional action. Together, these two constitute a *social institution*. Before defining reference and formative intentional actions and illustrating that they indeed are social institutions, I should first establish the nature of social institutions. Let us characterise these as possessing five primary characteristics:

1- *They are conventional*. Social institutions are contingent on conceptual frameworks that exist within specific spatial, temporal, and cultural contexts.
2- *They are self-referential*. Social institutions are referents produced by self-referential activity.
3- *They are generative*, in the sense that the collective generates the referent. Put another way, they are performative.
4- *They are collectively-constituted*, in the sense that social institutions are created and sustained through the action of a multitude rather than isolated individuals. Like S-kinds, they are *bootstrapped* into existence.
5- *They are normative.* Social institutions are susceptible to normative judgments, and agents within them display practices of sanctioning, imitation, and self-correction.

Here I intend to demonstrate that reference and formative intentional actions display these five characteristics, before returning to the issue of technological artefacts as artificial kinds constituted by social institutions.

4a. Referential practice

Consider the 'waiter's corkscrew' again. How do we come to refer to certain objects as 'waiter's corkscrews'? Consider an individual uninitiated in the socio-cultural framework within which we identify and refer to 'waiter's corkscrews'; this individual would manage to identity the alter-referent (the shaped piece of metal) through empirical observation, but would have no basis upon which to refer to this entity as a 'waiter's corkscrew'. The A-kind is embedded within particular conceptual frameworks contingent on space, time, and culture. That is, reference to artificial kinds is *conventional*.

For those of us initiated within the conceptual framework, this A-kind operates through self-referentiality. The referent 'waiter's corkscrew' exists because of continued references to the object as a 'waiter's corkscrew'. With each instance of reference to the object as a 'waiter's corkscrew', the referent is generated as well as stabilised. In other words, reference to artificial kinds is *generative* and *self-referential*.

However, self-referentiality does not operate through individual agents alone. Simply stating, 'this is a 'waiter's corkscrew' because this has previously been referred to properly as a 'waiter's corkscrew'' is no more than a tautology (Barnes, 1983). However, when a multitude of individual agents refers to and re-affirms a specific referent, self-sustained self-referentiality is possible. That is, taken collectively, an array of agents operating together creates a 'bootstrap' that reifies a particular A-kind. In and of myself, I cannot sustain the referent 'waiter's corkscrew' should everyone else decide to call the shaped piece of metal a 'handsaw'. A group of agents all operating with the same referential practice is required to sustain the referent; each individual concurrently bolsters and draws upon it. As Kusch notes, a concert of individuals is required for an A-kind to take hold, and referential practice must be policed through normative standards within the multitude (1999). That is, reference to artificial kinds is *collectively-constituted*.

We can further detail the normative mechanisms that operate to stabilise and reify these particular A-kinds. Should I walk into a store and attempt to purchase a 'handsaw', the clerk and possibly other customers would remind me that the object I am pointing to is actually called a 'waiter's corkscrew'. That is, my 'incorrect' reference would be subject to sanctioning practices. Through imitation and self-adjustment I would uphold the normative judgement concerning my incorrect reference to the object as a 'handsaw'; in altering my reference I would not only correct the individual instantiation, but also reify the 'correct' application. That is, reference to artificial kinds is *normative*.

To summarise, reference to artificial kinds is: conventional, self-referential, generative, collectively-constituted, and normative.

4b. Formative intentional actions[vi]

For the purposes of this analytic framework, I follow Kusch and Collins (1998) in their definition of actions as "things one can *intentionally* do *in a society*" (Collins & Kusch, 1998, p. 6, my emphasis). These are contrasted with behaviours, which consist mostly of physical movements and machinic motions. Unlike behaviours, which are susceptible to physical mimicry by uninitiated individuals, actions can only be carried out by those instructed and competent in the specific socio-cultural frameworks that situate agents within a particular context. For instance, no amount of repetition will translate waving my hand, a behaviour, into 'saying hello', an action. Actions are embedded within socio-cultural frameworks and as such are spatially, temporally, and culturally located. That is, actions are *conventional*. They exist only within a context and extend beyond the behavioural instantiations that are involved in their execution. Without a genuine comprehension of specific conceptual frameworks, no amount of physical mimicry of behaviour will suffice to carry out an action.

As a corollary, actions are always intentional, due to the fact that social awareness and conventional knowledge are required in each instantiation of a particular action[vii]. Individuals are conscious agents in the execution of actions, although this does not imply an absolute awareness of each action or preclude the existence of seemingly 'automatic' or 'unconscious' actions. For instance, learned and experienced waiters need not deliberate on the specific actions required to remove a cork from a bottle using a waiter's corkscrew; the action is seemingly automatic (or routinised). However, there does exist a necessary intentionality behind the event, which is linked with a broader collective and conceptual framework governing the action 'to remove the cork'.

Actions, then, are linked with particular collectives that influence each instantiation. In our example above, the collective surrounding the action 'to remove the cork' will influence the manner in which the waiter achieves his aim. Factors such as the size of the bottle, the type of cork, and the restaurant's own codes of conduct will all form part of a cognitive deliberation that will determine how the waiter carries out his task. The waiter will make this choice by drawing on a conceptual framework that relates these factors to the action 'remove the cork'. However, this conceptual framework is no essential or pre-determined body of knowledge; instead, it is a set of dispositions developed from previous instantiations of this particular action. The waiter will analogise each instance of uncorking to previous instances of similar circumstances; previous action will influence and shape the collective and the conceptual framework that in turn influence other actions. That is, actions are *generative* of the conceptual frameworks that guide future instances of these actions. Furthermore, these conceptual frameworks draw on nothing else but previous correct executions of these formative intentional actions. In this sense, actions are also *self-referential*[viii]. This self-referentiality is a collective process, and thus formative intentional actions are necessarily collective in nature. Collins and Kusch argue that actions can be categorised as S-kinds, as only "communities are able to recognize their behavioral instantiations." (1998, p. 23)

Importantly, these actions and conceptual frameworks require collectives to sustain them. Thus the specific actions involved in uncorking bottles in a restaurant *are constituted and sustained by the collective* of agents capable of executing those actions. Importantly, these collectives also make up the body of individuals competent enough to instruct future waiters in the 'correct' operation of waiter's corkscrew. The collective is then also responsible for the continuation of conceptual frameworks through aggregated individual actions. That is, the collective of initiated agents reifies future actions, conceptual frameworks, and the necessary qualities required of new initiates. Formative intentional actions, conceptual frameworks, and collectives are all inextricably interlinked.

As such, formative intentional actions also possess a *normative component*. As any waiter can tell you, there are 'right' and 'wrong' ways to use a waiter's corkscrew to open a wine bottle. These extend beyond the simple mechanical success of pulling out the cork with the waiter's corkscrew; normative judgments also encompass such issues of time, synchronisation of different movements, attention dedicated to the action, and so forth. These are all elements of individual instantiations of action. Normativity is built into the conceptual framework through action evaluation; like referential sanctioning, individuals within the collective police actions and are themselves susceptible to correction. Put different, this normative component is crucially linked to the collectively-constituted conceptual framework, which is itself dependent on previous instantiations of the action; thus, each execution of an action is both subject to and constitutive of the normative standards.

To summarise: formative intentional actions are conventional, self-referential, generative, collectively-constituted, and normative.

5. The 'bootstrapped' artefact: Ontology, function(s), normativity, and social institutions

Having established the theoretical tools of the performative theory of social institutions, I now intend to demonstrate their applicability to the study of technological artefacts. Recall from above that I identified four primary characteristics of all technological artefacts.

Namely, all artefacts have: a physical existence, purposeful design, functions, and normativity (of use and artefact quality). These four qualities conform to the general framework posited by the 'dual nature' theorists, and serve equally as well to distinguish and characterise technological artefacts within the theoretical approach I am exploring here.

While the 'dual nature' theorists focus on proper functions as the basis upon which artefact ontology, usage, and normativity operate, I argue that by problematising function as a socially constituted phenomenon, we can extend the theoretical and empirical work begun by the 'dual nature' programme. By decentreing and deconstructing function, we can identify the social processes that make artefacts intelligible, enable and sustain functions, and make normative judgements possible.

5a. Ontology: Technological artefacts are A-kinds

Technological artefacts are artificial kinds. Rather than understand the ontology of artefacts as proceeding from a 'dual nature' (Houkes & Meijers, 2006) and thus describe this ontology as a two-fold phenomenon dealing with structural physicochemical ontology and 'higher-order' functional ontology, I want to problematise this distinction. By using the model of artificial kinds, we can identify a sole ontological status for artefacts *as technological artefacts*. We can thus avoid the difficulty of relating two separate ontologies by realising that no such distinction exists: physical entities cannot in and of themselves be said to possess any form of technological ontology: technology is ultimately and necessarily bound up in social practice.

Let us continue with our example of a waiter's corkscrew. Consider a collection of various pieces of metal, all of which have broadly similar physicochemical constitutions. Let us further suppose that we choose to label a subset of these as 'waiter's corkscrews' and use only that subset to carry out actions that we believe are appropriate for 'waiter's corkscrews'. That is, we *speak and think of* only of a certain number of these pieces of metal as 'waiter's corkscrews', effectively excluding other pieces as 'not waiter's corkscrews'. Furthermore, we only employ those pieces referred to as 'waiter's corkscrews' in carrying out tasks we agree are appropriate for 'waiter's corkscrews', such as opening wine bottles. That is, we *use* only a number of these metal pieces as 'waiter's corkscrews'. Can we not state that these technological artefacts known to us as 'waiter's corkscrews' exist as 'waiter's corkscrews' for no other reason than a social process by which we call a subset of pieces of metal 'waiter's corkscrews' and use this subset as 'waiter's corkscrews'? Were we to suddenly include another piece of metal into the subset, this previously excluded entity would suddenly become a 'waiter's corkscrew' in name and practice. That is, its ontological status as a technological artefact proceeds from a social process. Although the object exists in space and time, it exists as a technological artefact only through social activity.

This social activity consists of reference and formative intentional actions. Referential practice and formative intentional actions are, as I noted above, social institutions. Social institutions are conventional, collectively-constituted and self-referential; as such, they require individual agents to be initiated into a particular conceptual frameworks. Participation in social institutions requires a familiarity and competency with a conceptual framework that renders all elements of the social institution not only intelligible, but also viable (Barnes, 1988).

Thus, we can state that the intelligibility of the waiter's corkscrew *as a waiter's corkscrew* arises not from its physical properties or some form of essential function, but rather from the collective practices that constitute its ontology. It would be absurd to speak or think about a waiter's corkscrew within a society that lacked wine bottles, corks, restaurants, or any of the myriad practices and institutions associated with or dependent upon the existence of this particular technological artefact. The identity of an artefact is not to be found solely in its structure. Neither is it to be found in an essential proper function, but within the social institutions that make this function viable.

Now, this is no way elides or delegitimises the physical constitution of technological artefacts. I want to make this particularly clear: materiality exists and is crucially important. However, physical construction is never a sufficient condition for the ontological existence of an artefact, and cannot be termed a distinct component of technologies. Its role as the material basis upon which social practices make artefacts intelligible is crucial, but is also necessarily limited. This is not to subscribe to a form of technological idealism, only to note the point that outside societies and collective practices, technological artefacts have no basis upon which to claim their ontology *as artefacts*.

Furthermore, this is not a claim that the design process is unimportant. Ultimately, however, design cannot account for our continued understanding and knowledge of artefacts. Only social practices can. While here I do not have the space to discuss design extensively, this aspect of artefacts warrants further exploration within discussions of ontology.

To summarise: technological artefacts exist in space and time as physical material. However, their ontological status *as technological artefacts* is a product of social institutions. Rather than posit a binary ontology based upon function as analytic linchpin, this approach argues that technological artefacts do not exist outside social practice.

5b. Function(s): Proper functions are S-kinds

I agree with Kroes & Meijers (2006) in their postulate that technological artefacts possess a quality of "for-ness"; that is, artefacts are employed by individuals in order to carry out certain tasks in our world. Artefacts have functions. However, my argument proposes a departure from the 'dual nature' model of function. By using an approach that focuses on social institutions, we can come to understand functions as generated by referential activity and formative intentional action. Put more succinctly, functions are generated *by*, rather than generative *of*, reference and use.

Rather than posit an understanding of function as the link between the physical and intentional components of technological artefacts (Vermaas & Houkes, 2006), or as an essential element of an artefact's physical structure (de Ridder, 2006) I argue that we must understand functions as social phenomena constituted by referential activity and formative intentional actions. Much like the production of a referent through self-referential concept application, here collectives define functions through iterative instantiations of particular formative intentional actions. Put otherwise, functions are entirely self-referential S-kinds.

First let us note that physical construction is not determinate of function. What would a culture unfamiliar with wine bottles and corks think of the corkscrew? Certainly its possible uses extend far beyond those that wine consumption calls for; no practical reason exists for the entity not to be used as say, a 'drilling device'. Rather, because the corkscrew exists as a

product of referential activity and formative intentional action, its functions are products of collectives. The social 'embeddedness' of the corkscrew determines the functions of the technological artefact. Functions, like self-referential concepts, are 'bootstrapped.' (Barnes, 1983)

Collective use determines function. Like Hansson, I argue that proper functions are "socially constituted facts" (2006, p. 20), operating in a performative fashion through collective 'bootstrapping'. Through mutual susceptibility and reinforcement (Kusch, 1999), individuals within the collective constitute the S-kind function. Consequently, any consideration of function is necessarily a consideration of social practices, and we must problematise the very notion of 'proper' functions.

While we may speak of testing unknown artefacts or conducting reverse engineering, function will only be established through practice and collective consensus (MacKenzie, 1996). A function becomes recognised as a proper function once a sufficient number of individuals within the collective recognise it as such; at this point of usage saturation, the S-kind's bootstrap is capable of self-sustaining self-reference (Kusch, 1999). Put otherwise, function follows from the establishment of a social institution of reference and formative intentional action.

As a result, "[p]roper usage is simply that usage communally judged to the proper, and is no more predetermined than idiosyncratic individual usage." (Barnes, 1982, p. 29) The validation and reification of a particular set of formative intentional actions here results from a collective mutual susceptibility that overrides and modifies individual behaviour in preference for the collectively-valid execution of particular actions (Barnes, 2001).

To summarise: formative intentional actions generate functions. Thus, we can explain our first characteristic of technological artefacts through the concept of social institutions. While spatio-temporal entities may display physical limitation to some usages, physical construction never predetermines the manner in which function will be constituted[ix]. Formative intentional actions are responsible for function through generative 'bootstrapping'. Rather than conceptualise proper functions as ascribed through use plans and based primarily upon structure, we must interrogate and critically probe the mechanisms by which functions develop, consolidate, and (seemingly) reify. Artefacts have functions in virtue of social institutions.

5c. Normativity: From structure to action

The 'dual nature' theorists argue that artefact normativity broadly consists of usage evaluation and artefact evaluation: that is, we can judge both how well an individual applies an artefact and how well the artefact operates. These, the authors argue, are linked to 'proper function'. By employing the Strong Programme, we can examine normativity as an integral component of the same social institutions that produce the notion of functions. In this manner, artefacts display normativity in three senses. First, the concept of an artefact can be mobilised 'correctly' or 'incorrectly'. Second, all artefacts and their users are subject to normative judgements of usage. Third, we can normatively evaluate particular artefacts: some technological artefacts 'work better' than others. I will argue that artefact normativity rests on the nature of social institutions as collectively sanctioned distributions of individuals.

As Kusch notes, "it is an essential feature of concepts that they can be applied *correctly or incorrectly*" (1999, p. 255, my emphasis) particularly when agents identify and map these concepts onto alter-referents. When one individual mobilises a particular artificial kind term, his/her use of the concept is 'correct' only insofar as the remaining members of the collective deem it to be so. Consider a collective of various types of corkscrews. Which of these are 'waiter's corkscrews' and which are 'winged corkscrews', 'rabbit corkscrews', 'army knife corkscrews', 'pocket corkscrews', and 'screwpull corkscrews'? Referring to a 'winged corkscrew' as a 'waiter's corkscrew' would be 'incorrect' due to a collectively-stipulated differentiation between multiple spatio-temporal entities endowed with broadly similar physico-chemical properties and collectively-determined functions. Which of these entities are indeed 'waiter's corkscrews' is a product of collective adjudication, and in this sense misapplication of the label (the concept of a 'waiter's corkscrew') is met with collective sanctioning (Kusch, 1999).

We can also observe that artefact usage is subject to normative examination; there exist 'correct' and 'incorrect' ways of using technological artefacts. Importantly, this evaluation of usage does not follow from an inbuilt 'proper function' with a corresponding use plan, but rather from collective judgements of formative intentional actions. Although there exist multiple behavioural instantiations of any one particular formative intentional action (Collins & Kusch, 1998), only a subset of these conform to normatively 'correct' artefact usage.

Consider the use of a 'waiter's corkscrew' by a waiter in a restaurant who is attempting to open a wine bottle for a group of patrons. Were we to consider proper function and end-goal acquisition solely, we would not sufficiently characterise the normative judgements associated with this particular usage of technology. The waiter is expected to position the bottle in a particular manner, to open it only after the patrons have inspected the label, to hold the bottle in a certain way while he performs the task, to use the corkscrew skilfully, to open the bottle as swiftly as possible, to ensure that no remnants of cork fall into the liquid, and to pour the wine in a specified physical manner and in a particular order. All of these considerations factor into our evaluation of the usage of the corkscrew. Were we to ignore these, we'd have to satisfy ourselves with the possibility of drinking cork residue and allowing the waiter to carry out the task with idiosyncratic impunity. When examined, this is not the case. Social conventions, policed by collectives, govern the waiter's formative intentional actions, which are after all both conventional and normative. As a result, 'good' or 'bad' use of the artefact depends crucially on the collective, not inbuilt 'proper functions'.

The final sense in which technological artefacts have a normative component relates to the actual artefact itself; as Franssen (2006) and Dancy (2006) note, a particularly salient quality of technological artefacts is their susceptibility to normative judgements of performance. That is, we constantly evaluate technological artefacts in normative terms. While the 'dual nature' theorists posit this phenomenon in terms of 'proper functions', I argue that we can explain it using social institutions and formative intentional actions.

I argued above that functions are 'bootstrapped' S-kinds, generated by particular referential practices and formative intentional actions. As such, when considering the performance of technological artefacts in the acquisition of specific goals, we need to look to these social institutions. An instrumentally 'bad' example of a particular type of technological artefact is so because it fails to effectively operate within particular formative intentional action. Rather than analyse instrumental quality through use plans and proper functions, that is through consideration of an artefact's ability to achieve a specific end-goal, I posit a broader analysis

that incorporates such crucial components of formative intentional actions as conventionality and collectivity. Where we to argue that a corkscrew's ability to achieve an end-goal exhausts considerations of its instrumental normativity, we would have to be satisfied with corkscrews that tore corks into a multitude of pieces so long as the wine were able to flow freely. But end-goals are not enough to satisfy normativity. As it is conventionally undesirable to drink cork remnants, only corkscrews that satisfactorily operated without breaking the cork to pieces could be categorised as 'good' corkscrews. This point may appear prosaic, but is deeply significant: like Franssen (2006) begins to argue, normativity is embedded in social institutions. Instrumental quality is a product of a collectively-determined set of formative intentional actions, which are necessarily conventional and normative.

To summarise: Normativity is ultimately a socially constructed, collective phenomenon, and does not rest upon any 'proper function' of the artefact in and of itself. We can judge a particular usage of a technology as 'correct' or 'incorrect' in the same manner that we can judge particular technological artefacts as 'good' or 'bad': through conventional and collective parameters for formative intentional actions. Rather than base normativity on an artefact's ability to accomplish its function, this approach looks to the social mechanisms that define function in order to identify their inherently normative components.

6. Conclusions and implications

The 'dual nature' theorists present us with a series of critical issues within the study of technological artefacts: artefact ontology, materiality, function, normativity, usage, and knowledge. They address these through an analytic conceptualisation of all technological artefacts as binary entities—consisting of structural and intentional components—and mobilise technological function as the analytic axis through which ontology, usage, and normativity are deconstructed and explored.

I hope that I have illustrated the myriad roles that function plays within the 'dual nature' framework. Proper function constitutes the mechanism used to unify and disjoin artefacts' dual components and forms the basis upon which normative statements are made viable. Functions themselves are conceptualised as following both from structural and social considerations, although they are ultimately subsidiary to physical construction and mechanical capability.

The 'dual nature' theorists ultimately do provide a compelling account of technological artefacts, and identify a series of crucial questions that both philosophers and sociologists of technology have neglected for an unfortunately long time (Kroes & Meijers, 2006). I believe that this initial conceptual postulate—a binary understanding of artefacts—does well in highlighting the problematic of technological artefacts. It provides the analyst with a series of useful frameworks and tools with which to explore those issues with which I engage above. However, by operationalising function as a basis for higher-order analysis, the 'dual nature' theorists circumscribe their exploratory programme.

First, the separation of 'structural' and 'intentional' components falsely separates physical constitution from the social processes that ultimately situate any artefact within particular sociocultural systems. Furthermore, by relying on functions and use plans to bridge the ontological and conceptual gap between these two components, the 'dual nature' theorists rely heavily on an individualistic intentionality that elides significant issues of social interaction and collective practices.

Secondly, by attributing to function a role as arbiter for issues of proper usage and normativity, the 'dual nature' theorists find themselves in an awkward position from which to adequately interrogate function itself as an effect of social practice. Proper function, although conceived of as partly social (Scheele, 2006), is ultimately bound up with physical structure and curbed by the design process and function ascription (Vermaas & Houkes, 2006; Franssen, 2006). By not fully engaging with the collectively-constituted, self-referential, and conventional character of function, these authors inevitably reify this phenomenon. This is particularly problematic when considering issues of so-called 'idiosyncratic usage' and the appropriation of specific technologies for purposes other than those intended by developers.

Finally, by focusing on use plans and proper functions, the 'dual nature' theorists run the risk of attributing too strong a sense of agency to function and design while not paying sufficient attention to collective practices. As de Ridder notes:

> Artefacts do not do anything without human agency. They 'work' only when we use them and as a result, an explanation of their working must include information about human action. (de Ridder, 2006, p. 82)

I would amend his comment by noting that *collective* action matters more than simply *human* action, often reduced to individual practice. As entities embedded within social and cultural systems, artefacts must be addressed using an analytic framework that incorporates a strong component of *collective* artefact sociality, rather than simply individual intentionality.

Thus while the 'dual nature' framework offers a promising platform from which to begin an analysis of the nature of technological artefacts, it requires further development. The performative theory of social institutions can be used to address these limitations by adding a *constructivist* and *collectivist* account to those issues identified by the 'dual nature' theorists. By engaging with ontology, function, use, and normativity through a social practices optic, this approach successfully supplements the tools developed in the special issue.

A Strong Programme approach provides a series of important benefits. First, it engages with function, ontology, and normativity symmetrically by seeking to explicate all three phenomena as products of the same social processes. In this manner, we avoid reifying function and gain the ability to conceptualise it as a social process. Moreover, we can elucidate the nature of technological artefacts without the need to parse these objects into a myriad of problems.

Second, by moving from an individualistic to a collectivist account, we can appreciate the critical importance of social phenomena in the constitution of artefacts, the determination and evolution of function, as well as in the delimitations of correct and incorrect usage. We gain the chance to examine these factors without losing the importance of individuals within the collective. This allows us to appreciate both the fluidity of artefact ontology, function, and normativity as well as their apparent stability.

Finally, by using the notion of social institutions, we can successfully address the sociality of all technologies without losing sight of the physical component of artefacts. Similarly, we can address and problematise those dualities posited within the 'dual nature' thesis, such as structure/intention (Kroes & Meijers, 2006), design/use (Vermaas & Houkes, 2006), materiality/sociality (Scheele, 2006), and knowledge/practice (Houkes, 2006).

At the core of a Strong Programme interpretation is the notion that technological artefacts are artefacts only insofar as social practice makes them so. Beyond the problem of physical construction, we must also consider the role that collective human practice plays in the *ontological* construction of a technological artefact. Briefly put, all artefacts are bootstrapped.

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[i] I am indebted to David Bloor for providing me with this term.

[ii] Note that these are in themselves N-kind terms. Often, we can observe such cascade-like distributions in referential practice. It is necessary, then, to be able to speak of an almost 'automatic' ability to identify and label N-kind terms. Importantly, this does not imply that referential practice is by any means without consciousness.

[iii] As Kusch notes, N-kind terms have both an alter-referential *and* a self-referential component (1997). For the case of N-kind terms, the self-referential component consists of the "criteria for classifying individuals" (ibid, p. 17) such as paradigms of classification. For the purposes of my current argument, however, I believe that my simplification is both useful and justified.

[iv] We can describe individual references to S-kind terms as *performative utterances*, as they bring about the state of affairs to which they refer. (Austin, 1962) However, this characterization fails to incorporate the crucial collectivist component of Barnes' work.

[v] For a comprehensive overview of *social institutions*, see Bloor, 1997.

[vi] Unless otherwise noted, this section refers to Collin & Kusch, 1998.

[vii] For a comprehensive argument of what I recognise is a particularly strong statement concerning intentionality, see Collins & Kusch, 1998, Ch. 2. It is important to note that here intentionality does not preclude habituation or routinisation: it simply reconstitutes the terms of the debate.

[viii] It may be possible to argue that function ascription in the 'dual nature' sense is a self-referential phenomenon. This might make the otherwise static concept a fluid, dynamic, and collective process. However, I believe it ultimately more useful to problematise function itself.

[ix] For a different perspective on the relationship between technical materiality and human agency, see the debate between Grint & Woolgar and Kling, both in *Science, Technology, and Human Values*, 17(3).