ARTIFACT OR EQUIPMENT? RETHINKING THE CORE OF IS USING HEIDEGGER’S WAYS OF BEING

Completed Research Paper

Kai Riemer
The University of Sydney
Sydney, NSW, Australia
kai.riemer@sydney.edu.au

Robert B. Johnston
University College Dublin
Belfield, Dublin 4, Ireland
robert.johnston@ucd.ie

Abstract

The IT artifact, conceived as a bundle of features or properties, is frequently seen as the core object of interest in IS. This artifact view of IT is deeply grounded in a Cartesian worldview that stresses a duality between the individual and the external world. We challenge this view by drawing on Martin Heidegger’s analysis of equipment in Being and Time (1927/1962). Using a stylized account of an IT implementation project we illustrate how the focus of attention shifts under this post-Cartesian worldview from IT as artifact to IT as equipment. This latter view conceptualizes IT as interwoven with other equipment, user practices, and individual identities, and highlights the need to appropriate new IT as equipment into an existing world of user practices. Applying Heidegger’s analysis of equipment to IT, we are able to systematically re-think what are the core and peripheral concepts and phenomena in the IS discipline.

Keywords: IT Artifact, Ontology, Heidegger, Appropriation, Cartesianism, IT as Equipment
Introduction

The IT artifact is frequently seen to be the core object of interest in Information Systems research (e.g. Benbasat and Zmud 2003). As such, the IT artifact is commonly conceived of as a bundle of features, a thing with properties (Orlikowski and Iacono 2001). In this conceptual paper we question the usefulness of such a view for understanding the adoption and use of IT. We argue that the artifact view of IT is deeply grounded in what is commonly referred to as the Cartesian worldview that stresses an ontological dualism between subject and object, between individual and the external world. The selection, adoption and use of IT in this view translate into the familiar story of fit between task, technology, and individual, which is essentially a story about the interaction between various entities, mental or physical.

We challenge this view by drawing on Martin Heidegger’s analysis of equipment, as introduced in Being and Time (1927/1961). Heidegger’s equipment analysis has not yet been fully expounded in Information Systems previously. Some studies have mentioned Heidegger’s notion of equipment loosely (Dourish 2001; Introna 1997; Turner 2005; Winograd 1995; Winograd and Flores 1987) and others have appropriated related concepts from Being and Time, such as his notion of being-in-the-world to outline situated action (Dourish 2001) humanness (Porra 1999) and management in practice (Introna 1997), or mood and Befindlichkeit to capture context and situatedness (Ciborra and Willcocks 2006). Others have drawn on his methodological contributions, applying phenomenology to technology phenomena (Introna and Ilharco 2003), or hermeneutics to understanding and knowledge (Butler and Murphy 2007; Cole and Avison 2007; Whitley 1999). A different stream has drawn on his later work on technology (Brown and Lightfood 1998) and the corresponding notion of Gestell (enframing) (Brigham and Introna 2006; Ciborra 2004; Ciborra and Hanseth 1998), both of which are out of scope with regards to our project.

Using a stylized account of a typical IT selection and implementation project we illustrate how the focus of attention shifts under Heidegger’s post-Cartesian ontology from IT as artifact to IT as equipment. We come to appreciate the often experienced messiness of IT implementation, captured in such concepts as “lack of adoption”, “user resistance”, “unfaithful use”, or “change management”, as the core story of IS and not the unfortunate by-product of an otherwise rational and straight-forward story of IT selection and implementation. Consequently, we will advocate focusing on IT as equipment as the core of IS, a shift that will not negate or render obsolete the orthodox, taken-for-granted view of IT as artifact, but will recalibrate what is core and what is peripheral in investigating IT in use. In doing this we address a key theme of this track which is using philosophy as a means to reveal and assess key assumptions that drive research agendas in the IS field.

Treating IT as equipment stresses the need for a holistic, sociomaterial approach that views IT as intimately interwoven with other equipment, user practices, and individual identities, and highlights the need to appropriate new IT as equipment into an existing world of user practices. By grounding our understanding of IT in Heidegger’s existential ontology, we are able to better understand and trace typical IS phenomena back to our being-in-the-world as concerned, practice-having beings (Dasein), for whom the using of equipment becomes co-constitutive of self. We offer the equipment view of IT as a distinctly different perspective through which Information Systems can distinguish itself from neighboring disciplines, such as Computer Science and Software Engineering, that have the (design of the) IT artifact as their core interest. We argue that, by focusing on equipment as the holistic notion of technologies-in-practice, Information Systems might come to better shape its disciplinary core.

The Cartesian worldview

The philosophical tradition, beginning with Aristotle, but mainly established by Descartes and Kant, rests on a few key principles, which we will spell out in this section. Often referred to as the “Cartesian worldview” this account refers to a wider set of beliefs that have entered everyday and scientific ontological understanding. While Descartes’ seminal work (1644, 2010) was influential in founding this tradition, a range of other influences (e.g. Hume 1740, 2009) have contributed to its proliferation (for a review see Scada 2004). The Cartesian worldview informs, at least implicitly, the orthodox position and mainstream research in the Information Systems discipline.
Cartesian dualism: subject and world; mind and objects

The Cartesian worldview rests on a dualism, which places human subjects vis-à-vis the ‘external’ world, which is populated by objects. Descartes refers to these objects as res extensa (extended substances); the dualism is completed by the human mind, the res cogitans (thinking substance). On this view, humans take in this external world via their bodily senses and hold in their mind an internal representation of the (objects in the) world. Hence, the Cartesian view posits a mind “in here” reflecting on, and directing the body to act upon, a world “out there”. To implement the independence of minds as subjects and worlds as objects the Cartesian view makes use of self-sufficient and independently existent entities as the contents of both the world and of minds. The mind is the substance that turns the external world of initially meaningless substances into the meaningful world that we experience. To have a mind essentially is to be human: “I think, therefore I am” (Descartes 1644, 2010).

The Cartesian worldview gains its most explicit expression in the various disciplines within Cognitive Science (Gardner 1985) that assert that human intelligent action is a matter of manipulating mental representations of the world (Johnson-Laird 1993). A typical account would go as follows. Things with properties in the world, through relations, form states of the world. Which states are allowed in the world is determined by the laws of nature. A lawful transition between allowed states is an event. The mind is taken to contain mental representations of possible states of the world, at least of those parts of the world that are available through sense data. Based on our mental representation of the external world we are able to formulate intentions and plans, make decisions, and perform actions in the world. In doing so, two important mental representations are those of the current state of the world and the intended state of the world at any time. The mind reasons about how to close the difference between the intended state and the current state by a series of actions. This series of actions is a plan. The body executes this plan and the actions become events that convert the current world state into the intended world state. If this transformation is not complete re-planning occurs. Thus, our mental representations of the world, as well as other mental states, such as feelings, moods, intentions, are taken to be entities defined by properties that take part in interactions with entities in the world outside the mind.

Cartesian grounding of IS

The Cartesian worldview informs, at least implicitly, the mainstream accepted research logics of the IS discipline, namely the 1) process logic, 2) variance logic, and 3) fit logic, that underlie well-known theories and inform typical research approaches in IS research. Finally, 4) the Cartesian worldview is responsible for how we commonly view the IT artifact itself.

The “process logic” studies how processes (actions or sequences of actions) convert an input state into a later output state (Markus and Robey 1988). This is a logic of change. Research following this logic exposes certain events that occur sequentially in time and bring about certain phenomena, such as in systems development projects (e.g. Montealegre and Keil 2000; Newman and Robey 1992). The so-called “variance logic” studies how the value of a property of one entity co-varies with the value of a property of another entity when they are causally related. These entities are things or states and often at least one of these entities is a mental state, such as a feeling or intention, conceived as a mental entity characterized by certain attributes. This is the common logic of causation. Dominant theories such as the Technology Acceptance Model, TAM, (Davis and Bagozzi 1989; Davis 1989) or the Unified Theory of Adoption and Use of Technology, UTAUT (Venkatesh et al. 2003) rest on this logic. These theories offer formalizations of human behavior based on assumed causal relationships between the properties of material entities, such as the IT artifact, and mental entities, such as beliefs, internalized norms, and intentions. Finally, there is the “fit logic”. Under this logic there is a precondition for a certain state change to occur (such as adopting a technology) that the properties of one or more mental entity (such as a task, a cognitive style, etc.) should match in some specific way the properties of some entity in the world (such as a technology). If this fit between the properties of the two or more entities obtains then the transformation or process can occur. This is a logic of ecological fit. Typical theories and approaches in IS using this logic are the task-technology-fit (TTF) (Goodhue and Thompson 1995), media choice theories (Daft et al. 1987; Dennis et al. 2008) and the concept of strategic alignment (Henderson and Venkatraman 1999).

Finally, our common understanding of the IT artifact itself is also grounded in the Cartesian, cognitivist worldview. The IT artifact is commonly described as a bundle of features, that is an entity that bears
certain properties (Benbasat and Zmud 2003; Orlikowski and Iacono 2001). As such, this view of the IT artifact is derived from the so-called design stance that posits that the function of an artifact (‘what it is for’) is designed into the artifact, giving it its form. This is best expressed in the following quote:

“According to the design stance, an artifact is intentionally created by a designer to fulfill some function. The intended function is the factor which determines the artifact’s surface properties, the actual functions it can serve (the intended function as well as others) and its kind. In that sense, the original intended function is the artifact’s essence. Thus, a coffee mug is capable of containing liquids because that is what its designer intended.” (Matan 2001)

Consequently, in the Cartesian worldview artifacts are seen to have two types of properties: physical and functional properties. This is precisely what distinguishes objects of nature and man-made artifacts as the former have only physical properties while the latter additionally have functional properties that allow us to deduce from the object what it is for (e.g. see Ahn 1998).

A Cartesian account of IT selection and adoption

This section presents a stylized account of IT selection and adoption with which we illustrate the ways in which the Cartesian worldview, as introduced above, underlies our familiar way of thinking about IT. Later we will revisit and reinterpret this story using Heidegger’s analysis of equipment. Please note that as this is a conceptual paper we do not draw on a real case but rather spell out in a general and abstract way the typical process of IT selection and adoption.

We expose the typical process by which an organization comes to choose and implement a new software package. Our story begins after the organization has identified the need to buy and implement a new software package. It has been argued that the subsequent process involves “selecting (...) a software system and a co-operative vendor, implementing this system, and examining the practicality of the new system.” (Wei and Chien 2005, 47). Hence, the first concern is to select the best software package available. Textbook knowledge asserts that this is typically done by eliciting task requirements and matching these requirements with the features of available products (Valacich and Schneider 2012). To do this, requirements are elicited and formulated as a request for quote (RFQ). After tendering and having received the lists of software package features the organization needs to select a system and make a decision to buy.

Selection of a viable software system is done by comparing requirements with software features and determining the software with the greatest fit. The underlying logic to this exercise is thus one of task-technology fit (Goodhue and Thompson 1995). A range of frameworks (Stefanou 2000) and formal methods exist in the Information Systems literature that are applied by organizations to determine the best match between requirements and product specifications (see Bernroider and Koch 2001), such as criteria ranking, matching or scoring methods, or more complex mathematical approaches (Wei and Chien 2005). Regardless of the method, the process is one of matching the properties of two entities (the task and the IT artifact).

Under the fit logic this process should lead to the “right” solution. Having achieved a good fit between user tasks and artifact we would now expect that, after installation, the user base will start using the system and intended benefits will begin to materialize. Unfortunately, in this process various things tend to “go wrong”. In fact, much research in the Information Systems field is concerned with what happens past this point in the process.

For example, users individually have to adopt the new artifact and users have often been found to adopt only partially or to resist the new technology outright (Jiang et al. 2000). Others have pointed out that users engage in unfaithful or adaptive use in that they use the new artifact in ways that were not intended by the software developers or the organization’s decision makers (Beaudry and Pinsonneault 2005; DeSanctis and Poole 1994). Finally, engrained user habits have been identified as standing in the way of adoption (Limayem and Hirt 2003). In fact, an extensive research stream has emerged in Information Systems to investigate this ‘messiness’ of technology adoption by users (Lee and Kozar 2003; Legris 2003) and elaborate models have been proposed to capture the messiness of post implementation behaviors (Jasperson and Carter 2005). Just as the selection of software by matching properties of the task and artifact entities is grounded in the Cartesian worldview, the identified factors impacting on user adoption
of technology (e.g. habit) are likewise treated as properties of mental or physical entities (e.g. the IT artifact, the user, task or other entities) (e.g. Conner and Armitage 1998); the research approaches typically follow the variance logic.

From the organization’s point of view a situation of non-adoption and user resistance is unsatisfactory. While some organizations opt to apply pressure by making use mandatory (Brown et al. 2002), a range of different post-implementation measures are typically employed to increase adoption and use, such as user training or change management. In essence such measures again follow a fit logic in that they aim to adapt one entity to another, e.g. the user (and his/her capabilities) to the new artifact and the associated way of working.

In the next section we will present an alternative philosophical approach through which to interpret IT, not as an artifact (an entity with properties), but as equipment, holistically involved with other equipment, human projects and human identities. This change of viewpoint will allow us to reappraise many aspects of this IT use and adoption story and in particular to see the messiness of adoption not as a set of peripheral complications to an otherwise “clean” adoption decision process, but rather as the very core phenomenon of the IS discipline, namely the appropriation of IT as equipment into use contexts.

Heidegger’s analysis of equipment

In this section we lay out Martin Heidegger’s alternative to the Cartesian worldview as introduced in Being and Time (1927; 1962). However, since Heidegger’s contribution in Being and Time far exceeds what we are concerned with in this article we will concentrate on those aspects that are relevant for understanding matters of IT and its use. In particular, we will discuss Heidegger’s analysis of equipment and its role in human practice.

Heidegger has formulated his ontology as a fundamental critique of the tradition of philosophy, as captured in the Cartesian worldview. As we have exposed above, the traditional topic of ontology has been to elaborate and categorize the kinds of entities there are in the world. Heidegger’s innovation in Being and Time is to ask an entirely new question: what are the kinds of ways that entities can be in the world? Heidegger’s argument is that traditional philosophy has confused the ontic question about the properties entities posses with the ontological question about the ways of being of such entities (Dreyfus and Wrathall 2007). This question is important for our project because one of these ways of being is that of being ‘equipment’.

Overview

Heidegger argues that his question can only be answered by first examining the peculiar way of being of that entity who asks the question. This being Heidegger calls Dasein. The way of being of humans (Dasein) is engagement in practices. The unique mode of human existence is to be such-and-such by doing such-and-such. For instance, a doctor not only practices medicine but is a doctor because s/he practices medicine. It is important to understand that Dasein is not an individual person who gives a mental account of his/her own experiences. Dasein denotes the being of humans whose mode of existence is distinct from the mode of existence of other entities, namely to be engaged in practices that at the same time define what they do and who they are.

1In doing so, besides using Heidegger’s original work (in the English and German editions), we will draw on and quote from the work of Berkeley philosophy professor Hubert L. Dreyfus, in particular his 1991 commentary and his 2007 lectures, which are accessible in Podcast format. When quoting from the podcasts, we will quote the relevant podcast file and the reference in hours, minutes and seconds within the respective file. Moreover, as “Being and Time is notoriously hard to translate” (Dreyfus 1991, ix), we will sometimes provide alternative translations for the concepts in questions, or even the German original. Moreover, we will draw on secondary literature for illustrating certain aspects as we see fit.

2In the German original Heidegger uses the term Existenz to denote the way of being of humans, which gets translated as existence in the English version (Heidegger 1962). However, existence fails to capture the essence of Heidegger’s notion of the human way of being; Existenz in German has a much richer meaning, which goes beyond the connotation that something exists or ‘is’. Rather, one of its meanings captures more holistically the way in which someone constitutes their self through engagement with the world. Therefore we use the term engagement in practices, or short engagement, to denote the human way of being.
Heidegger can then define two other ways that entities are in the world on the basis of how they are encountered by Dasein in the course of such self-constituting practices. The first way of being he calls *ready-to-hand*, which means that the entity is encountered as a means (an “in-order-to”) for a practice. A carpenter who is engaging in hammering encounters a hammer not as an object but as *equipment* both for doing what carpenters do (hammering nails) and for being what a carpenter is (a craftsman). The carpenter in his familiarity with the hammer encounters it as a means, as an *in-order-to* in Heidegger jargon. Equipment as such is constituted through its relationship to other equipment, typical activities and purposes for which it is used, and lends itself to use without reflection. The carpenter has an embodied skill for using the hammer in order to drive nails and as equipment the hammer lends itself inconspicuously and naturally to this task.

On the other hand entities may be for Dasein *present-at-hand*. In this way of being, entities are constituted through their inherent properties rather than through their use in practices. Here we recover the substances of traditional ontology. Entities are present-at-hand for Dasein as substances when they are encountered in an analytical, reflective way (for instance, as objects of curiosity, analysis, design, practical reflection or scientific attitude). In the same way, in a certain sense, humans have a substantial existence as physical bodies and humans can encounter their own practices and experiences as present-at-hand. In this distanced and reflective stance, practices show up as behaviors, tasks, and goals; experiences as mental states, emotions and moods; and social interactions as norms, rules of behavior, and social structures. In this way Heidegger recovers the subject/object dichotomy of traditional philosophy. However, while the Cartesian worldview takes the existence of objects in the world as ontologically fundamental, for Heidegger the present-at-hand way of being in which entities are encountered as substances with properties is a derivative way that humans can relate to the world (e.g. to reflect mindfully).

However, Heidegger argues that the traditional worldview fails to account for and explain everyday human existence since most of the time humans are absorbed in practices in a non-reflective and entirely practical way, which is to say that they encounter equipment as well as their own existence in a ready-to-hand way. The contents of experience fade into the background; the distinction between self and external world (including others) fades; one is involved in the world in such a way that the world and all its contents (including the body, things, artifacts, mental states, and others) are ready-to-hand and so are both invisible and subordinate to one’s self-defining practices. Table 1 summarizes Heidegger’s three kinds of being and the ways of being.

<table>
<thead>
<tr>
<th>Being</th>
<th>Way of being</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dasein</td>
<td>Human existence is being-in-the-world, which is involvement in a practical, absorbed and concernful way. The familiarity with everyday practices and the world is the background against which all being is rendered intelligible.</td>
</tr>
<tr>
<td>Equipment</td>
<td>Equipment presents itself as an in-order-to in a holism of other equipment and practical involvements. It is most genuinely ready-to-hand when it is withdrawn during use and not experienced at all.</td>
</tr>
<tr>
<td>Substances</td>
<td>An entity is present-at-hand when it is individuated and encountered as a bundle of properties.</td>
</tr>
</tbody>
</table>

---

3 This quote is from the *Pensées* (Pascal 2008).
Equipment holism and the in-order-to

As indicated above, in our everyday dealings we do not encounter equipment as separate from other equipment but as holistically embedded in our everyday practices. Consequently, equipment is not encountered as (a collection of) objects with properties but as a holistic means, or what Heidegger calls an ‘in-order-to’ (das Um-zu):

“Strictly speaking there is no such thing as an equipment; to the being of any equipment there always belongs a whole, in which it can be the equipment that it is. Equipment is essentially an in-order-to. A totality of equipment is constituted by the various ways of the in-order-to.” (Heidegger 1962, 97)

In that sense, a hammer is not encountered as a wooden shank with a metal blob but as a to-put-nails-in, a door is not seen as a wooden plank with a handle but as a to-leave-the-room. This implies that equipment for humans is not made intelligible on the basis of its properties but by the purpose it serves in a situated context of other equipment and human practices. Equipment is only equipment when in its use context. The main point here is that what shows up as a given artifact upon present-at-hand inspection is indeed different equipment in different contexts. Equipment is not encountered as a self-sufficient, individuated entity with properties but practically as a means in its rightful place of a practice. A word processor for example is not encountered as a software artifact with a set of features but as a to-write-letters, to-capture-ideas, to-edit-a-memo, depending on the use context.

“Equipment can genuinely show itself only in dealings cut to its own measure (hammering with a hammer, for example): but in such dealings an entity of this kind is not grasped thematically as an occurring Thing, nor is the equipment-structure known as such even in the using. The hammering does not simply have knowledge about the hammer’s character as equipment, but it has appropriated this equipment in a way which could not possibly be more suitable.” (Heidegger 1962, 98)

The quote further captures that equipment is not encountered thematically or ‘consciously’. Heidegger argues that our understanding for using our equipment is not one that resides (primarily) in the mind but is a primordial understanding of the nature of an embodied skill that can best be described as know-how (Dreyfus and Dreyfus 2005) as opposed to know-that, or precisely what Polanyi (1967) describes as tacit knowledge.

Moreover, equipment only becomes a particular kind of equipment in a use context and through its place in a referential whole. There would not be any equipment without other equipment and the practices of using equipment. Equipment cannot be understood in isolation merely by assigning to the present-at-hand entity a certain predicate (“for hammering”) or property equal to its use: “Equipment cannot be made intelligible in terms of objective substances plus subjective use-predicates.” (Dreyfus 1991, 66). Heidegger uses the example of a hammer that can only be understood as what it is when one knows about nails and wood, practices of building houses from timber and the human need to seek shelter; the equipmental nature of the hammer cannot be understood without the knowledge of everything that makes a hammer into what it is in a certain equipmental context. Hence, equipment always draws its particular in-order-to from its place in the referential whole. For example, the being of the word processor as equipment (and its particular in-order-to) arises from its entanglement with other equipment (computer, keyboard, monitor, desk, printer) and practices (having meetings, writing and printing agendas, taking notes, writing memos).

Suitability and appropriateness of equipment

Dreyfus in his analysis of Heidegger’s account points out that in order for equipment to fit in a referential whole, and thus to be equipment, it needs to be both suitable and appropriate (Dreyfus 2007b). Firstly, for an artifact to become equipment it needs to be suitable (zugeeignet) for the intended task; it needs to have the kinds of present-at-hand properties that enable it to do what it is supposed to do. However, while this is a necessary condition it is not sufficient as the above discussion should make clear.

Secondly, and more importantly, equipment needs to be appropriate (angemessen), which means it has to have its place in the totality of other equipment, shared practices, as well as user skills and social orthodoxies. This in turn means that its appropriateness is always judged against the background of a practice and the same artifact might be judged appropriate in the context of one practice but not another. Instant messaging for example might be suitable to facilitate workplace communication but it might not
be deemed appropriate in every context, depending on the nature of the practice. Moreover, appropriateness captures what one normally and appropriately does with equipment. For example, while instant messaging might be deemed appropriate to negotiate the lunch break, for conveying sensitive information or making someone redundant might not be ‘what one does’.

When we further scrutinize the relationship between suitability and appropriateness of equipment it becomes obvious that suitability underlies appropriateness in a causal (necessary, but not sufficient) way, which means that without suitability any artifact would not be able to function as the equipment that it is in a given context. Thus in a causal (Cartesian) view, suitability underlies appropriateness.

On the other hand, appropriateness is difficult to analyze at all in the Cartesian view simply because it cannot be decomposed into a relation between entities. More importantly, one of Heidegger’s main arguments is that the Cartesian philosophical tradition has overlooked that equipment is intelligible to us first and foremost through its appropriateness, that is its place in the referential whole as equipment. Thus, in terms of intelligibility, appropriateness underlies suitability; only by already knowing what something is for can we suitably reflect on its properties.

“The thing is irreducible to what we represent of it. It is also irreducible to the causal conditions that produced it, since, in Heidegger’s famous words, ‘the jug is not a container because it is produced, but rather the jug must be produced because it is this container’ (Heidegger 1994, p. 6).” (Harman 2010, 24)

**Ways of being of equipment**

The natural way of being of equipment is readiness-to-hand (Zuhandenheit). Equipment, at the most basic and natural level, is encountered by Dasein as ready-to-hand in that it is being used in a practical, absorbed and even invisible way, without any need for reflection.

“We do not always and continually have explicit perception of the things surrounding us in a familiar environment, certainly not in such a way that we would be aware of them (...), they become accessible precisely with regard to their unobtrusive presence.” (Heidegger 1988, 309)

Heidegger posits that this non-reflective mode of use, when equipment functions properly as an in-order-to, is in fact constitutive of the peculiar way of being of equipment:

“The less we just stare at the hammer-Thing and the more we seize hold of it and use it, the more primordial does our relationship to it become, and the more unveiledly is it encountered as that which it is -- as equipment.” (Heidegger 1962, 98)

Consequently, equipment is itself most genuinely equipment only when actually being used, or to put it another way: “Equipment in use is equipment as it is in itself.” (Dreyfus 1991, 66). Equipment, when being most genuinely ready-to-hand ‘withdraws’ and is not experienced at all. Almost paradoxically, equipment is truly encountered as what it is only when it is not experienced at all:

“The peculiarity of what is proximally ready-to-hand is that, in its readiness-to-hand, it must, as it were, withdraw [zurückziehen] to be ready-to-hand quite authentically. That with which our everyday dealings proximally dwell is not the tools themselves [die Werkzeuge selbst]. On the contrary, that with which we concern ourselves primarily is the work” (Heidegger 1962, 98)

Hence, when we are absorbed in using equipment we do not notice equipment, provided it is functioning properly: “ready-to-hand refers to equipment that remains concealed from view insofar as it functions effectively” (Harman 2010, 18). Rather, we are solely preoccupied with the task at hand: “The self must forget itself, if lost in the world of equipment, it’s able to actually go to work and manipulate something” (Heidegger 1962, 405). A user engaged with writing a text with the word processor will, if everything goes well, not notice the computer nor the keyboard or word processing program; the equipment ‘withdraws’ from the user’s experience while the user is fully engaged with the text.

Equipment however is only ready-to-hand until something goes wrong when the equipment shows itself conspicuously and reflection is required to resolve the problem: “An entity malfunctions and loudly announces itself; later, the same entity might retreat into the background and be taken for granted once again” (Harman 2010, 19). In situations of breakdown equipment becomes unready-to-hand (see also: Winograd and Flores 1987, 36). But unreadiness-to-hand is also encountered in other situations, such as during learning when the user is acquiring the skill necessary for being involved with equipment in an
absorbed way. It is worth mentioning that equipment, when unready-to-hand, will still not be encountered in a present-at-hand way. What shows up are certain aspects of equipment that are relative to the task and relative to our involvement in the referential whole, such as ‘the hammer is too heavy’ or ‘the software is too slow’. Obviously, these are not properties of a tool, because properties are meant to be independent of a situation.

**Intelligibility of equipment against the background of practical understanding**

Having discussed the ways of being of equipment it is necessary to point out that equipment can be individuated and be encountered as present-at-hand. This is precisely the case in situations where one is inspecting, designing, building, or theorizing about them. In such cases it is an artifact that presents as the object of attention. Moreover, an artifact will also be present-at-hand when someone is confronted with an unfamiliar object that he or she does not know anything about and hence fails to understand skillfully what it is.

Heidegger’s fundamental point is that equipment, an in-order-to, cannot be deduced from the present-at-hand view of any artifact: “No matter how sharply we just look at the “outward appearance” of things in whatever form this takes, we cannot discover anything ready-to-hand” (Heidegger 1962, 98). To the contrary, any artifactual object is only intelligible to us against the background of our everyday (common sense) understanding for its place in the referential whole of human practices. For example, in order to know what a word processor is and skillfully reflect on it or talk about it we have to assume an abundance of background knowledge and acquaintance with the holistic entanglement of computers, printers, keyboards, the significance of text and written expressions in our culture, the history of script that brought about paper sizes and font types, etc.

The example shows that equipment can only be understood on the basis of our familiarity with the holistic (cultural, contextual) background of equipment and practices (see Taylor 2006). Fundamentally, Heidegger argues that this familiarity with the world is constitutive of our way of being as engagement in practices, often translated as being-in-the-world. This is best expressed in the following quote by William Blattner:

“Heidegger offers an alternative description of experience. He argues that our fundamental experience of the world is one of familiarity. We do not normally experience ourselves as subjects standing over against an object, but rather as at home in a world we already understand. (…) our sense of identity, of who we are cannot be disentangled from the world around us. We are what matters to us in our living; we are implicated in the world (…) That we are primordially familiar with the world and cannot be disentangled from it leads Heidegger to one of his lasting terms of art, being-in-the-world, which is (one of) his name(s) for our being.” (Blattner 2006, 12)

**The significance of equipment for human identity**

The above quote expresses that an important aspect of the human way of being, as engagement in practices, is our familiarity with the world, iour common sense background knowledge, that we have acquired by growing up in the world and on the basis of which we understand the things around us and ourselves. This points to a final but crucial point. For Heidegger, equipment, practices and human identity are inseparably entangled as they form one holism. Constitutive of Dasein is to have practices. Practices depend on equipment for their performance. Therefore, Dasein as the human way of being depends on equipment. But the being of equipment depends on practices and therefore on Dasein. Hence, as much as equipment depends on Dasein for what it is, so Dasein is constituted through its engagement with equipment:

“A world comprises the totality of inter-related pieces of equipment. Each piece of equipment being used for a specific task (…) [with] a set of purposes to which these tasks are put. (…) in performing these tasks we acquire or assume an identity (or identities) as carpenters, academics and so forth.” (Turner 2005, 797)

---

4 Strictly speaking, the entity that has the way-of-being of present-at-hand is not equipment. Therefore we will speak of artifacts, when we denote individual objects that are dealt with in de-situated ways, e.g. during design.
Hence, the using of equipment in our everyday practices takes part in how we see ourselves and how we express who we are:

“This Dasein, which is us, by its using equipment, and acting in the world gives itself an interpretation of what it is to be a human being in general, and a human being in that particular culture, and this particular human being, like being a teacher.” (Dreyfus 2007a, at 1h 13m 30s)

In summary, equipment plays an essential role in the defining of self: we derive meaning from using equipment and equipment is meaningful for us. At the same time, the unique way of being of every Dasein also co-constitutes the particular role equipment plays, how it is used, in essence what it is. Consequently, equipment is not just constituted by its place in a practice and equipment holism, but equally by Dasein itself. As a result any separation of Dasein and equipment in the above argument is purely analytical; they are part of the same holism that Heidegger calls “world”.

Table 2 collects together conclusions about the nature of IT in use derived from the above Heideggerian analysis of equipment.

<table>
<thead>
<tr>
<th>Equipment aspect</th>
<th>Equipment view of IT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Equipment as in-order-to IT</td>
<td>IT is not encountered by users as artifacts with properties/features but as equipment for doing something, the particular notion of which is derived contextually from its place in the referential holism.</td>
</tr>
<tr>
<td>2) Equipment always forms a holism with other equipment</td>
<td>IT (e.g. hardware and software) is not normally experienced by the user as distinct entities but holistically in a practically engaged way.</td>
</tr>
<tr>
<td>3) Suitability of equipment</td>
<td>It is necessary but not sufficient that an IT artifact has the right properties in order to fulfill the task it was assigned to.</td>
</tr>
<tr>
<td>4) Appropriateness of equipment</td>
<td>IT not only has to be suitable but also it has to be appropriated into an existing holism of other equipment, work practices, and identities that make up the particular work context.</td>
</tr>
<tr>
<td>5) Intelligibility against background understanding</td>
<td>New IT will always be interpreted by users against the background of existing practices, equipment, skills etc.</td>
</tr>
<tr>
<td>6) The ready-to-hand way of being</td>
<td>When everything goes well during use the user does not notice or pay attention to IT as equipment (the focus is on the task, e.g. writing a text).</td>
</tr>
<tr>
<td>7) The present-at-hand way of being</td>
<td>When IT is not in fluent use by a skilled user, IT can be present-at-hand (be present as an artifact with features). This is the case when it is being inspected, reflected upon, being built by a developer, etc.</td>
</tr>
<tr>
<td>8) Unreadiness-to-hand and breakdown</td>
<td>In cases of breakdown (e.g. when IT malfunctions), aspects of IT show up. These are experienced and can only be understood situationally, relative to the task context.</td>
</tr>
<tr>
<td>9) Familiarity with equipment</td>
<td>Absorbed use of IT is based on the user’s learned (embodied) skills. Fluent, everyday use of equipment is not guided by instructions (not even ‘subconsciously’).</td>
</tr>
<tr>
<td>10) Significance of equipment</td>
<td>IT as equipment is co-constitutive of users’ professional identities; the user’s view of themselves in turn has a bearing on the role and using of IT.</td>
</tr>
</tbody>
</table>

**An alternative IT adoption story: Putting equipment into practice**

In this section we revisit our earlier story of systems selection and implementation by drawing on the various aspects of Heidegger’s equipment analysis as summarized in table 2 and discussing the changes that are exposed once we shift to this post-Cartesian ontology.

When we approach the above story from an equipment perspective the goal of the organization becomes one of changing the organization’s holism of equipment and practices. In doing so, the task-technology-fit
logic of requirements analysis and systems selection accounts only for a rather small part of this process. However, the systems selection part of the story is not unimportant; it needs to be ensured that the new system is capable of doing what it is supposed to do. But this present-at-hand analysis of artifact properties will only ensure suitability. And even this part of the story becomes problematic if we appreciate that users do not encounter their existing equipment, tasks and ways of working in a present-at-hand way as independent entities with stable properties. What shows up for the users are contextual aspects of their work environment, the translation of which into present-at-hand task requirements is at the core of the manifold problems that have been exposed in user requirements engineering, captured in the phenomenon that different stakeholders in systems design see the world with different eyes (e.g. Sarkkinen and Karsten 2005). This is aggravated by the fact that existing ways of working are often based on embodied skills and absorbed, non-reflective routines that are not explicitly accessible to introspection and reflection, which is precisely captured in the notion of tacit knowledge (Polanyi 1967). Thus, even for aspects of IT to show up at all to users the IT has to be problematized for them, either by a deliberate intervention by a systems analyst, or spontaneously through systems malfunction.

If we assume that the organization was able to select a suitable IT artifact using the fit logic derived from the Cartesian worldview, the new system should fit the user task. Consequently, the user should be able to see and appreciate the fit and start using the new technology. However, the experiences from the field and the abundance of research on user adoption are testimony to the fact that this story is also too simple. The equipment analysis above shows that what actually needs to happen is making the step from suitability to appropriateness, from artifact to equipment.

In the following sub sections we revisit and reinterpret various aspects of the messiness story through the Heidegger lens. In doing so, we come to understand the messiness as precisely what is to be expected when users encounter new artifacts that are not yet equipment.

**Unintellibility**

When the users in our story first encounter the new software it is unlikely that this new artifact is (fully) intelligible. We have shown above that artifacts are generally only intelligible to us because we are familiar with the equipmental and practice background that lends the artifact its function and allows us to understand what it is for. In contrast to the Cartesian view, intelligibility of the artifact does not arise from its inspectable properties. When we encounter a new and unfamiliar object we will have to interpret the new thing on the background of the existing equipment complex and our engagement in practices. The issue is that the new system is not yet equipment so it doesn’t present as an in-order-to. Moreover, since users and decision makers (or designers) typically do not share the same familiarity background, they will come to different, often conflicting, interpretations. This will especially be the case when the expectation of the new artifact is to induce change to the very work practices on the basis of which the new thing is interpreted by the user. Hence, the fact that users might come to different interpretations of the artifact leading to resistance, or that they might engage in ‘unfaithful use’, is quite to be expected on the equipmental view of IT.

**Unreadiness-to-hand**

When the new system is given to the users it is put against an existing, holistic workplace structure (a world in Heidegger terminology). As yet the new artifact does not yet show up as an in-order-to. To the contrary, it first and foremost acts as a potential obstruction in an otherwise well-established ready-to-hand work practice environment. Consequently, even if the user, by way of interpretation, comes to see its benefits and starts using the new software system the user will at the beginning experience ongoing breakdown and unreadiness-to-hand.

In general, using of a new software system typically starts with having instructions and following rules. Only through learning in context are we to acquire skills and habitual ways of using (Dreyfus and Dreyfus 1996). That is, we gain the know-how to just deal with the new thing unreflectively. As the new artifact gradually blends in to the referential whole of equipment and withdraws in the course of our transparent coping it then takes on the way of being of equipment, which is readiness-to-hand. This is when the artifact is no longer encountered as a thing that needs manipulating by following instructions but is ready-
to-hand in our everyday practices. Expertise is acquired and the using has gone from reflective acting to absorbed dealing (e.g. Dreyfus and Dreyfus 2005).

From the above it becomes obvious that adoption in this sense cannot be usefully viewed as a one-time decision. Rather, it is a complex learning process that plays out over time. Thus, what it takes for a new IT artifact to go from a first unready-at-hand encounter to blending in and withdrawing during everyday use should be a central topic of the IS discipline.

**Suitable but not appropriate**

However, individual learning is only part of the story. More generally, the new system must become part of a modified equipmental holism; it must become entangled with other equipment, user practices and social orthodoxies, a process we might usefully call appropriation as it involves precisely the move from suitability to appropriateness. However, fundamentally this is a social process that involves collective sense-making against the shared equipmental and practice background. Essentially, the new system needs to be “enrolled” into a practice rather as a new user would be (e.g. Ciborra 1999).

We conclude that, rather than perceiving adoption as an individual decision it needs to be understood as a complex social process, which is not yet well understood, but should be among the core agendas for IS.

**Threat to individual identities**

Finally, we want to point out that users might feel threatened or even insulted by the new artifact. Use of equipment is at the heart of our human way of being, which is to be engaged in practices. Practices and equipment are constitutive of self to the degree that individuals express their (professional) identities through the equipment they use. Replacing this equipment might in the worst case equate to tearing apart one’s (professional) life-world, one’s existence, which was built on the basis of what one does and therefore how (in what way) one “is” an accountant, a manager, a sales clerk, etc.

Existing equipment is intimately entangled not only with existing work practices, but the user’s identity. New technology might challenge the very identity of this person. What is often characterized as a recalcitrant resistance to the inconvenience in changing one’s routine or habit is now seen properly as identity preservation. We argue that these identity-related aspects of tool use have been largely overlooked so far, as they have no meaningful place in the Cartesian story.

**Conclusion: Putting IT as equipment at the core of IS**

In this section we attempt to make good on our claim that Heidegger’s existential ontology and analysis of equipment allows us to re-evaluate what should be the core of IS. This section should be appreciated not as an attempt to argue that existing topics and research approaches are wrong and must be replaced by shiny new ones. Instead, it attempts to show how a focus on IT as equipment inverts the relationship between core and peripheral concepts and phenomena in the discipline, focusing researcher attention on issues that, although part of the discipline already, are typically marginalized. At the same time it addresses one of the key themes of the track as we show that philosophical analysis (particularly ontology) can reveal the hidden assumption of a research field. Others have made related arguments about the necessity to recognize the embeddedness of IT in human practices (Callon 1986; Hutchins 1995; Ihde 2001; Latour 2005; Suchman 1987) but we contend that Heidegger’s analysis of equipment provides a precise and powerful didactic tool for making this point. The following subsections clarify our contributions and open up avenues for future research.

**What is the core entity of the IS discipline?**

Recent calls to define the core of the IS discipline place the IT artifact as the focal object of IS research attention (Benbasat and Zmud 2003; Orlikowski and Iacono 2001). The artifact is also implicitly the focus of recent proposals to position the IS discipline as a design science (e.g. Hevner et al. 2004). We have argued that the focus on this artifact is deeply grounded in the Cartesian tradition. While the artifact story
can usefully capture and systematize suitability of IT for a given task it is incapable of fully addressing the
effective use and adoption of IT in organizations, which has always been the main issue of IS in
distinguishing itself from neighboring disciplines (Keen 1980).

We argue that if this is the case then the core entity should be IT as equipment because this is how IT
manifests itself when IT is most genuinely used by people in organizations. We have used Heidegger’s
existential ontology to show that IT viewed as equipment is a distinctly and fundamentally different
conception of IT. While the artifact view usefully describes the underlying material properties of IT that
renders it suitable to fulfill a task (e.g. organize and present data, perform calculations, facilitate
information transfer) the Cartesian approach cannot capture how IT is encountered by the user, since IT
has a different way of being when it is equipment than when it is present as an artifact.

What is the core phenomenon of IS?

The artifact view places as the core phenomenon of IS the use of IT conceived as a decision conditioned by
the fit of the properties of IT with mental attributes of individuals. This view formalizes the conditions for
successful IT implementation as task-technology fit or other causal relationships between entities, groups
of entities and their properties. This is consistent with the dominant Cartesian view that places IT as an
entity in the (external) world over and against a separate (internal) mental world of use intentions. In this
view IT adoption manifests as a fit between properties of IT, viewed as a self-sufficient entity, and mental
states in the mind of a manager or potential user. This is evidenced by the current orthodoxy in IT
adoption research as reflected in theories such as TAM or UTAUT (Davis 1989; Venkatesh et al. 2003).
The problems and complexities that occur in putting use intentions into practice are then relegated to the
periphery, as a matter of practical difficulties in the ‘messy’ real world.

By contrast, on the view of IT as equipment the central phenomenon would be the way in which IT as
equipment becomes entangled with other equipment, practices and identities, or equivalently, how IT is
appropriated. Rather than being treated as an incidental deviation from the otherwise clean pathway of IT
implementation, as has been expressed in the phrase “unfaithful use” (DeSanctis and Poole 1994),
appropriation becomes the core phenomenon of the IS discipline. On the other hand, the conditions
under which IT artifacts are suitable for use within a work context now appear to be the peripheral
(although again not unimportant) aspect of the phenomenon, since such suitability is merely a condition
of possibility of the main appropriation phenomenon.

While we do not yet fully know how to theorize or achieve in practice all aspects of appropriating IT into
existing work practices, what is highlighted by the equipmental analysis presented above is that these
issues are part of a unitary phenomenon and are not simply diverse “problems” encountered when an
otherwise “ideal” approach to adoption conceived as decision or fit meets the unfortunate “messiness” of
the “real world” (as the Cartesian analysis would have it). Rather, we assert that they are the core
phenomenon that IS (as opposed to neighboring technical IT disciplines, such as Computer Science,
Software Engineering, Requirements Engineering etc.) should study. In essence, we argue that IS as a
discipline is in the equipment business, not in the artifact business. We advocate rethinking what is core
to the discipline (equipment, which is IT in use) and what is peripheral (the artifact story of IT
development and selection).

What is a suitable theoretical grounding of the IS discipline?

When the IT artifact is taken as its core object of interest and selection and adoption decisions are taken
as the key phenomena, then a suitable theoretical grounding of IS would naturally be the decision
sciences, behavioral and cognitive theories of human decision making, ontologies of the thing-property
kind (e.g. Weber 1997), and theories of artifact design, which dominate the current IS literature. By and
large these underpinning theories of IS are informed by the Cartesian worldview as we argued above.

However, if IT as equipment is taken as the core object of interest and appropriation into practices is the
core phenomenon then the IS discipline requires a conceptual philosophical ground that supports a
precise description of the holistic nature of IT as equipment and the (social) world of practical user
involvements into which it is appropriated. In recent years, researchers in the discipline have made
inroads into articulating such a grounding by using the notions of social construction of technology
While a comprehensive literature review is beyond the scope and purpose of this paper a good overview of this research stream is provided in (Leonardi and Barley 2010). However, while scholars have begun investigating how technologies become interpreted by individuals and groups in context (e.g. Orlikowski and Gash 1994) many accounts are still grounded in the Cartesian worldview, or as Orlikowski puts it ontologies of separateness (Orlikowski 2010). For example, technology interpretation is said to involve “the transfer or modification of a previously existing cognitive framework to a new situation” (Leonardi and Barley 2010, 12). Hence, while the phenomenon of appropriation as interpretation in context is appreciated existing research often still attributes technology interpretation to a property of the individual (e.g. a mental frame) or group (e.g., its culture). More recent accounts, such as technologies-in-practice (Orlikowski 2000), entanglement or sociomateriality (Introna 2007; Orlikowski 2007), explicitly argue for overcoming the dualist approach when studying technology and people and express the need to view the material and the social as holistically entangled (Orlikowski and Scott 2008). Using the term technologies-in-practice Orlikowski recognizes the phenomenon of hermeneutical interpretation of technology in practice: “A community of users engaged in similar work practices typically enacts similar technologies-in-practice, where through common training sessions, shared socialization, comparable on-the-job experiences, and mutual coordination and storytelling, users come to engage with a technology in similar ways” (Orlikowski 2000, 411).

In this paper we have offered Heidegger’s existential ontology as a fully articulated, powerful framework capable of providing such a grounding for an IS discipline with IT as equipment at its core. We have demonstrated the usefulness of this conceptual framework in exposing new insights and research topics (see table 2) including new topics relevant to IT appropriation, such as individual identity and the role of background practices for making equipment intelligible, all of which are difficult to formulate in the Cartesian worldview. We have shown that Heidegger’s analysis of equipment and its relation to being-in-the-world provides a holistic alternative to the traditional Cartesian dualism and a basis for future inquiries into the nature and anatomy of IT appropriation. Thus, while many aspects of this alternative core phenomenon of appropriation have been studied before, Heidegger’s existential ontology has the potential to unite diverse research endeavors in the most fundamental way possible; by grounding them in a different understanding of our way of being in the world as humans engaged in practices co-constituted by equipment.

What would the new core say about design?

Arguably most IS academics feel that IS should contribute something to the production of better IS in practice. This is mirrored in the recent push towards design science, a vision for IS that in its current form is grounded in the Cartesian worldview as it places its emphasis on designing artifacts and theories thereof (Hevner et al. 2004).

However, if IT as equipment is taken as the core entity of IS design and change would not (primarily) be about endowing IT artifacts with suitable properties or features. Rather, it would be a holistic endeavor that involves the simultaneous shaping of IT artifacts, use practices and identities; in short, production of the entanglement of the material and social in context. Design would become design of IT as equipment.

While we do not yet fully understand the implications of IT as equipment for a design perspective in IS, placing this entity at the core shifts our focus from the artifact to the use practice. Design itself, as well as theorizing about design, therefore cannot be seen as an isolated activity. Building equipment quite logically becomes a holistic, embedded, contextual endeavor. Creating equipment emphasizes design in context not creation of an artifact that is first built, then tested and then deployed. Such a view lends credibility to and implicitly underpins long-standing developments in software engineering that stress user involvement and the embedded nature of design, captured in such approaches as participatory design (e.g. Kensing and Blomberg, 1998; Muller and Kuhn, 1993), co-realisation (Hartswood et al. 2002) or human factors (e.g. Salvendy, 2006), that argue for contextual design where software is developed together with users and thus entangled and contextually embedded at the same time.

However, many of these developments have occurred in neighboring disciplines such a computer science and software engineering that naturally tend to formulate design in Cartesian terms (however, see
(Winograd and Flores 1987) for an early account of design influenced by Heidegger’s work). In IS, which focuses on the use of IT and its role in organizational innovation, we would question the wisdom of importing into IS a Cartesian view of design as evidenced in the recent versions of design science. The notion of designing IT as equipment could rally a new perspective for design in IS.

**What methods are required to research IT as equipment?**

We have argued above that the Cartesian worldview that grounds the dominant view of IT as artifact in IS leads naturally to the main research logics and methods that are indeed dominant in the discipline. These methods seek to establish causal relationships between entities and their properties and are described in more detail in an earlier section. We point out here that this emphasis on the causal view of the relationship between IT and people only captures the condition of suitability of IT for use.

The concept of appropriateness of equipment from Heidegger and our interpretation of IT use on this view as appropriation cannot be analyzed within the Cartesian framework of individual minds and world alike, populated by substances with properties in causal relations. The suitability of IT for use expressed in terms of its properties is merely a precondition for appropriation. Consequently, the dominant research logics of the IS field are insufficient to research appropriation of IT in the way we have characterized it. Since intelligibility grounds appropriateness what is additionally required is methods that are capable of investigating how IT as equipment becomes collectively intelligible (meaningful) to users on the basis of their (shared) background practices as they collectively appropriate these technologies into and change those collective practices. Thus, an IT as equipment view would advocate for rich data collection methods that give access to the background of intelligibility that underpins human agency in dealings with technology, and lends itself naturally to the application of hermeneutic methodology (Cole and Avison 2007) and ethnomethodology (Garfinkel 1967) both of which are Heideggerian in origin (Klein and Myers 2001).

Table 3 summarizes our conclusions.

<table>
<thead>
<tr>
<th>IS Issue</th>
<th>IT as artifact view</th>
<th>IT as equipment view</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core entity of IS</td>
<td>The IT artifact conceived as a bundle of features or properties.</td>
<td>IT as equipment as part of a holism of other equipment, use practices and user identities.</td>
</tr>
<tr>
<td>Core phenomenon</td>
<td>The use of IT conceived as a decision and conditioned by the fit of the properties of IT with mental attributes of individuals.</td>
<td>The use of IT conceived as the appropriation of IT into a holism of other equipment, work practices and user identities.</td>
</tr>
<tr>
<td>Conceptual underpinning of IS</td>
<td>The Cartesian worldview as expressed in popular theories of human behavior, decision-making, thing-property ontologies and theories of design.</td>
<td>An ontology capable of capturing the holistic nature of equipment and its relation to use practices. We propose Heidegger’s analysis of equipment and being-in-the-world.</td>
</tr>
<tr>
<td>Nature of Design in IS</td>
<td>Design is the creation of IT artifacts with suitable properties.</td>
<td>Design is the holistic endeavor of simultaneous shaping IT artifacts, use practices and identities.</td>
</tr>
<tr>
<td>Nature of Research in IS</td>
<td>Research is discovering the causal relations among entities and their properties.</td>
<td>Research is discovering how entities are made intelligible to humans against a background of their practices.</td>
</tr>
</tbody>
</table>
References


