The equipment nature of 'the so-called' IT Artifacts – Holistic ontology based IS design principles

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Abstract

The topic of Information System (IS) design has been extensively covered in design science literature. After introducing two main ontological stance of IS design, holism and dualism, this paper develops four IS design principles that bases a holistic orientation. We first present the two underlining IS design cores of dualistic ontology, externality and determinacy, and their influence in the process of IS design. We then discuss end-users' holistic IS practice based on Heidegger's tool analysis framework. After presenting new technology appropriation case study, we further discuss holistic based IS design principles and their application in different IS design activities. Based on the empirical evidence, the paper demonstrates the effect of ontological level stance on the operational level of IS design, the concept of breakdown and its contribution to the improvement of worksystem. We conclude by highlighting the need for further study of holistic IS design principles and its implication for organization.

Keywords*: Ontology, IS design principles, Equipment, IT artifact, way of being*

1. Introduction

The topic of IS design has been extensively explored in IS research publications (March and Smith 1995; Hevner, March et al. 2004; Peffers, Tuunanen et al. 2007). These literature generally recognize the importance of both the material (technological artifacts) and the social (end-users) and the 'emergent practices that results from the interaction between the two' for a successful IS design (Gregor and Jones, 2007, Leonardi and Barley, 2008). On this regard, IS design literature have developed different notions such as social construction (Bijker, 2010), situated entanglements, (Orlikowski, 2005), imbrication (Leonardi, 2011), assemblages (Latour, 2005) and enactment (Boczkowski, 2004) to study the relationship between the social and the material. In other words, "the ontological status of IT-in-use" (Riemer and Johnston, 2013b) is a well-recognized phenomenon where the interaction between end-users and IT is studied under the banner of holistic ontology.

A holistic ontological orientation is one that 'mangles' (Pickering, 1993) the social and the material and presents them as a *whole*. Customarily referred to as a Cartesian worldview, dualism is the opposite ontological orientation where the 'social and the material' are distinctively defined as independent 'subjects' and 'objects' from the get-go (Jackson, 2008). Holistic ontology critiques dualistic characterization of technology as a collection of material properties presented to users "with its skin off" (Heidegger 1927) or as material properties to be 'encountered by subjects' (Wheeler 2013). Even though, much IS design literature have acknowledge the notion of socio-material relationship between users and technological artifacts, the logic of dualism has been extensively used to design IT artifacts (Riemer and Johnston, 2011). Thus, what remained under researched, is the implication of holistic nature of end-users

IS practice for the design of material artifacts. This study explores the possibilities of deriving contingent IS design principles based on holistic IS practice.

Thus, our agenda in this paper is to apply a holistic worldview in the process of developing IT artifacts. In doing so, we use Heidegger's 'tool analysis' concept as the theoretical background (Heidegger, 1927). The 'tool analysis' concept provides a non-dualistic framework to examine the relationship between the social and the material (Riemer and Johnston, 2013b). We draw on a case study of a new learning management system called Moodle (Modular Object-Oriented Dynamic Learning Environment) deployed on three campuses at Mid Sweden University, Sweden.

The paper proceeds as follows. First we start building our theoretical framework by outlining the Cartesian worldview and its influence on IS design. Second, we explore end-user's holistic IS practice based on Heidegger's tool analysis framework. Third, based on holistic IS practice, we derived IS design principles. Fourth, after presenting our case study, we further discuss these principles based on our findings. Finally, we conclude with a discussion of holistic IS design implication for different IS design dimensions.

2. Theoretical Background

The notion of holistic IS design steams from a well-documented relationship between 'the social and the material' component of organizations (Orlikowski, 2005, Simon, 2012). In defying technological determinism, supports of constructivist have shown that technology is socially constructed. For example, Leonardi and Barely (2010) have documented a two decades long IS literatures where scholars have used different labels such as transference, intra-group interaction, situated improvisation and social influence to denote the social construction of IS post-implementation. They have concluded that IS and organizational scholars have convincingly showed the inseparable relationship between the social and the material.

Design Science Research (DSR) has been criticized for its exclusive focus on IT artifacts (Hovorka and Germonprez, 2009). Gregor (2006) suggested that DSR theories should be able to give "explicit prescription" to develop IT artifacts. In general, DSR literature focuses on identifying organizational IT problems, develops, evaluates, and implements IT artifacts as systems instantiations, abstractions of potential systems (as systems requirements and specifications) and as ISD methods (March and Storey, 2008). Even then, proponents of DSR have acknowledged that design science should "explain how artifacts are adapted" to their environment (Hevner et al., 2004). Iivari (2007) proposes the three worlds of popper (1978) as 'a starting point' to discuss ontological bases for DSR. In his work, the ontology of DRS is based on a) material nature (evaluation of IT artifacts) b) evaluation of IT artifacts against perception of it by humans and c) IT artifacts relates to human actions, organizations and new knowledge produced as a result of IT artifacts. In the later ontological base, Iivari tried to lay a foundation for the holistic nature of 'the social and the material' and the emergent knowledge that can be obtained from the interaction between the two.

In contrast with holistic nature of relationship between 'the social and the material', the dualistic ontology has been a prominent orientation in designing information systems. In the next section, we will demonstrate dualism's influence on IS design. In what follows, holistic 'IT-in-use' and foundation for holistic IS design principles will be presented.

2.1. Dualist ontology of IS Practice

The core of Cartesian worldview is an ontological stance of dualism: "the position that the world is composed of two orders of being" (Jackson, 2008). Dualism ontology detaches the world and the

knowledge of the world; creating a separation between an 'object' to be observed and a 'subject' to be an observant. Dualism achieves such knowledge based on two closely related conceptual components. The first component of dualism, *externality*, signifies the existence of independent reality, regardless of practical interaction with a subject. The externality concept also advocates the possibility of obtaining an objective knowledge about the world reality merely as an observant. Knowledge claimed objectively as an observant, dualism assumes, has a value-neutral and *deterministic* characteristic (Jackson, 2008). The second component of dualism, *deterministic/positivistic* characterization of knowledge, is the ontological base for technical rationality in IS design (Schön, 1999). The *externality* component of dualism ontology is widely visible in IS practice while *determinacy* dominates IS design process.

The concept of 'externality' scripts the adoption of new technology in dualist IS practice. Here technology is considered as an external entity that needs to be comprehended and match-make with the knowledge of work practice. In this process, some technologies (e.g. ERP system) may trigger changes organizational routines (Leonardi, 2011), while others can be flexible enough to fit in to the existing work practice. Regardless of the outcome, dualistic ontology aims at match-making the knowledge of 'worksystem'[1] (Alters, 2012) with technological functionalities. Systems are expected to effortlessly tune with existing practices, which promotes technical rationality in IS design. The second component of dualism, determinacy, is the ontological base for such rationality.

2.2. Dualist ontology of IS Design

The concept of determinacy implies that objective knowledge about the world, without "ignoring any of its important features", is feasible (Jackson, 2008). Webster dictionary defines determinacy as "a) the state of being definitely and unequivocally characterized or exactness b) the state of being determined or necessitated" (Merriam-Webster, 2011). The concept infers two notions: 1) Techniques used to mirror the reality/knowledge of the world is required to guarantee high-level of rationality. 2) Such knowledge has a causal essence of determining (enabling and constraining property) reality.

If we look at commonly used methods in the IS literature and IS design methods, we can see the influence of dualistic determinacy. In the IS research field, for example, Orlikowski and Baroudi (1991) reported that 96.8 percent of IS articles published between 1983-1988 follows a positivist approach. The following quote communicates the determinacy effect on IS design more clearly:

> "Technical rationality is the positivist epistemology of practice and depends on agreement about ends. When ends are fixed and clear, then the decision to act can present itself as an instrumental problem. But when ends are confused and conflicting, there is as yet no problem to solve ... 'One way of solving problem definition is to convert' ends to constraints and utility function and means to command variables" (Schön pp. 41-47)

Consequently, technical rationality demands designers to clearly identify end-user's requirement by converting 'problems' to technical functionalities at the outset. With pre-determined ends in mind, technical methods like controlled process modeling, normalization, 'temporal causal chain, logical reduction' (Truex et al., 2000) and other engineering means were applied to understand user requirements and accomplish rationality. This led to the creation of what Feenberg referred to as "self-generating technology", where technology is used not only as solution, but also as a mechanism to understand user's

[1] Alter (2012) defines worksystem as "a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal or external customers". While using the term, we will keep Alter's notion of worksystem.

requirements (Feenberg, 1999). In the next section, a theoretical perspective of holistic IS practice will be presented.

2.3. The Holistic logic of design and implementation of IS

Holistic ontology does not put a “break between the world and knowledge of the world” (Jackson, 2008) to understand reality. In holism, reality means *practice* between any two given entities. In addition, the reality of the world is not grounded in rationality or 'perfect knowledge' nor does it pursue such endeavor. In fact, it embraces the unexpected and sees emergent knowledge as a success. Holistic account is that a whole has a meaning that cannot be recognized from its parts. Consequently, holistic ontology is the ontology of *context* and *practice*.

2.3.1. The Holistic view of IS practice

There have been excellent works in the research field discussing Heidegger’s ‘tool/equipment analysis’ concept (Khong, 2003, Leiter, 1996, Smith, 1991, Wheeler, 2013, Dreyfus, 1990), therefore we shall only touch the main points. In particular, we built on Heidegger's first work of 'Being and time' and his later commentaries on technology (Heidegger, 1927, Heidegger, 1982), Riemer and Johnston’s (2013a, 2011) application of Heidegger's equipment analysis in the IS field, Hubert Dreyfus’s (1990, 2000) number of commentaries, as well as other equally important sources of IS design works (Winograd and Flores, 1986, Feenberg, 1999).

A) Practice and Context – as a way of being

Dasein is the term Heidegger chooses to denote the ‘*way of being’* human and it is literally translated as “everyday human existence” (Dreyfus, 1990). Human uses ‘practice of engagement’ as a *way of being* human in the world (Riemer and Johnston, 2013a). Dasein becomes *being* through practice of engagement. In addition to be in ‘*the midst of action’*, Dasein "is its past, whether explicitly or not. . . Dasein has grown up both into and in a traditional way" (Heidegger, 1927). Unlike dualism, "meaning is fundamentally social and Dasein is situated within a world and within a tradition" (Winograd and Flores, 1986). Dasein involves in, or in Heidegger’s term "*thrown into*" context, and its everyday action has a ‘historical context’ as a background (Heidegger, 1927).

B) Technology’s way of being for Dasein

Heidegger introduced two basic modes of technology’s way-of-being for Dasein: ready to hand and present at hand. Ready to hand refers to the ‘holistic structure of an artifact called equipment’(Riemer and Johnston, 2013a). To make the equipment mode of an artifact clear, we can take different office IT supplies as an example - they exist in our office as being ‘ready to hand’. We can use a keyboard in our office to type words on MS application without giving a conscious attention to its *being* a keyboard. It is there as 'in-order-to-write' (Riemer and Johnston, 2011) equipment. Without an idea and context of writing, a monitor, office supplies and other modern understandings of technology, a keyboard is nothing but a piece of plastic.

Dasein’s engagement of present at hand can be explained in three ways (Harman, 2010): a) *a conscious attention to artifacts b) a scenario where broken artifacts causes our routine work to be ‘temporary disturbed’*, which is referred to as un-readiness-to-hand (Dotov et al., 2010), and *c) artifacts as a natural physical objects*. Using our cognitive abilities we can call-up artifacts for a conscious reflection. For example, as we type on our keyboard, we can start to consciously think that we are using an artifact called keyboard made of different keys, different colors and functions – thus making it present at hand artifact. The second scenario is when artifacts malfunction and get our reflective attention – which is also called un-readiness-to-hand state of an artifact. In our keyboard example, some keys may refuse to type or the

keyboard itself can malfunction. Un-readiness to hand can be permanent, where artifacts can be discarded, or reversal in which the un-readiness to hand artifact is repaired and become ready to hand again.

2.4. From holistic IS practice of engagement to IS design

Dasein's main practice of engagement with IS artifact is in "taking-them-for-granted" ready to hand mode (Harman, 2010). Even in cases where we selectively choose to give attention to specific properties of artifacts, we fail to give reflective thoughts to surrounding environment that makes the current reality true. For the most part, these supporting realities are withdrawn (Heidegger, 1927) from our consciousness and continue to perform 'their unnoticed labors' (Harman, 2010). Present at hand practice of engagement does not imply that users are practicing completely new surrounding or worksystem. If we look closely, a present at hand encounter is always 'a ready to hand oriented' encounter. Based on knowing-in-practice, competent users already know how system should work as oppose to outside system analysts.

Heidegger's concept of *breakdown* is another main Dasein's experience of present at hand engagement. The notion of breakdown indicates "the disruption of ongoing, non-reflective activity results in a shift to a more deliberate form of practice" (Koschmann et al., 1998). In breakdown, the ready to hand object becomes a reason for "circumspective deliberation", in which the object becomes present at hand, and Dasein's response is that of a *reflection (Koschmann et al., 1998)*. To achieve a ready to hand mode again, Dasein's response is similar to Maturana and Varela's (1980) "structural coupling" where organism "effectively responses to the perturbations it experience" (Feenberg, 2002).

The next section implicates Dasein's holistic practice of engagement in IS Design activities. To examine the application of holistic based IS design principles, we have adopted Winograd and Flores (1986) assumption of four main dimensions (activities) that a system analyst[2] commonly follows when developing computer systems. The reasons for choosing these activities as our dimension are as follows. First, Winograd and Flores implement these dimensions while discussing steps that are usually followed to develop computer systems for end users. Second, design science literature (March and Smith, 1995, Hevner et al., 2004, Peffers et al., 2007b, Peffers et al., 2007a) generally referred, at least implicitly, to these activities as parts of IT design tasks. Third, these dimensions provide common lens to analyze system development for both holistic and dualist ontologies.

A) Defining problem domain and user requirement

Traditionally, a system analyst is tasked with finding 'problems' in the worksystem and 'solutions' in the IS knowledge base (March and Smith, 1995). In addition, the analyst is expected to define domain of application in the outset. The main purpose of defining problem domain is to derive goal oriented 'ends' (Schön, 1999) in such a way that different 'potential solutions' can be presented as a choice for the domain of application.

This approach appears to be valid, but in the light of Dasein's practice of engagement, is short-sighted for the following reasons:

- From the system analyst perspective, end-user's activity is analyzed in the present at hand mode while Dasein's usual practice of engagement is ready to hand.

[2] IS-designers have different Job titles. We will consistently use system analyst to designate IS designers.

- In its daily activists, Dasein is *thrown* into work systems in which Dasein uses the knowing-in-action or tacit knowledge to interact. Such tacit knowledge has no criteria or rules from which a system analyst can derive instrumental goals or ends. Design happens in the work environment on a daily basis “in the absence of specific expected criteria” (Weick, 1977). In addition, end-user’s “know more than they can say” (Schön, 1999). Consequently, it is implausible to characterize all domain tasks as a collection of operational ends.

- In defining task domain and user requirements, designer’s concern is finding ‘problems’ and formulating them as a "structure of goals” (Winograd and Flores, 1986). Dasein’s practice of engagement indicates solutions that already exist in work systems. Thus, dualistic approach of formulating 'problems' in the worksystem and looking for 'solutions' in the IS knowledge base is not aligned with Dasein’s practice of engagement.

Thus, based on end-users interaction with a worksystem elements of ‘the social and the material’, contextual articulation of worksystem is needed to define both the problem and application domain. The first principle of worksystem articulation, presented later in details, bases Dasein’s contextual interaction with worksystem elements.

B) Formal representation of user requirement

Cotemporary organizations are emergent in their nature (Weick, 1977, Truex et al., 1999), and “ends can be confusing and conflicting” (Schön, 1999). Yet, at this stage system analysts are expected to have a well-formulated problems and formal representation of user requirements. Such a representation is usually "constructed from messy problematic situations" (Schön, 1999). If we see this process from Dasein's practice of engagement, formal representation of end-user’s problem using ‘means to end’ logic is yet another short-coming of dualistic method of IS design for the following two reasons:

- For Dasein, “real world is an open system” that involves different articulations including, but not limited to, workarounds, coordination of different work systems, unanticipated errors, opinions and believes, and inconsistent workflows (Gerson and Star, 1986). Such a worksystem cannot be translated to a simple means to end relationship.

- In dualistic ontology, system analysts use complicated IS jargons and methods to state problems (Truex et al., 2012). Even though, problem setting is an important step to design computer systems, "it is not in itself a technical problem" (Schön, 1999), hence does not require a technical methods and terms.

The second principle of worksystem representation roots on the reasoning of “irregular, untidy and subject to approximation” nature of users’ requirement (Hovorka and Germonprez, 2009). For dualistic tradition, defining a task environment mainly involves either finding a corresponding technical object (property) in the IS knowledge base that fits problem domain or creating operational ends based on ‘objectified’ problems. Little attention is given to the “blindness inherent in the way problems are formulated” (Winograd and Flores, 1986). Formally representing these requirements using technical methods can lead to omitting or misrepresenting problem domain.

C) Abstractions to computer representation

The third dimension of IS design is concerns with embodying abstraction in the computer structure. Computer structures are designed to develop objects, properties, and application domains but ill-prepared for accommodating breakdowns. Breakdowns have a potential to create application domain as much as computer objects and properties. For example, a workaround can easily replace an application domain

created by a computer structure and change the work system. Subsequently, using computer level structures to create application domains provides “impoverished possibilities” (Winograd and Flores, 1986) to model Dasein's ready to hand practice of engagement.

Based on the limited nature of computer structure, the principle of breakdown (the third principle) highlights the need for focusing on the processes of structural coupling rather than solving specific tasks. In other word, targeting process design demands the inclusion of *process* by which users are expected/anticipated to use the designed product.

D) Development of objects and properties

At this stage, the system analyst is ready to design computer representations as bundles of objects and properties to fit user requirement tasks. Dualism develops material properties based on end user’s present at hand encounter using a 'fit logic' (Goodhue and Thompson, 1995). After rigorous evaluation of technological properties ‘by surrogate user in the present at hand mode’ (Riemer and Johnston, 2011), an artifact will be ready to be implemented in the task environment. In other words, the first technology adoption process is mainly considered while developing material properties. Technology’s way of being, on the other hand, is a readiness to hand mode which is transparent enough to be used "without any cognitive effort" (Riemer and Johnston, 2013a).

Closely related to the third principle, the forth principle of system thinking suggests that the ‘search procedure’ should focus on the contribution of technical properties and objects to the whole work system than to specific tasks. In other word, the improvement of holistic domain of application is considered to be the goal and technological properties and objects are expected to be co-constituted with other equipment in the worksystem. The following table summarizes an analytical IS design principles based on holistic ontology. After presenting our case study, these four principles are discussed in detail.

Holistic IS design principles	**Description**	**Applicable IS design dimensions**
The principle of worksystem articulation	Articulation of worksystem history includes local knowledge and practice. Both problems and solutions are in the worksystem. System Analysts should work in the domain of application.	Defining problem domain and user requirement
The principle of worksystem representation	Representation of worksystem is not a ‘technical problem’ in itself.	Formal representation of user requirement
The Principle of breakdown	Structural coupling. Hermeneutic methodology. Breakdowns as a revealing best practices opportunity. Application of domain space anticipates potential breakdowns.	Abstractions to computer representation
The Principle of System Thinking	Holistic domain of application. Best practices and domain of applications are continuously emerged. Developing ‘equipment’ instead of properties and objects. Minimizing blindness.	Search procedures

Table 1. Contingent IS design principles based on Dasein’s practice of engagement

3. The case study

Our objective is to explore end user's holistic based IS practices. Thus, a closer look at user's new and long term appropriation process of technology is considered appropriate for our study. This new technology is Moodle, an open source course management system (moodle.org) implemented in Mid Sweden University, Sweden. The University has more than 1500 teachers and 13,055 students in three campuses using Moodle learning system. Moodle, currently managing about 250 courses, works with other existing IT systems like Ladok (National student data center) which runs ATLAS software and Student portal (local student administration) based on LIFERAY software.

3.1. Research Method

Our methodology to explore embedded IS design principles is based on thorough 'content analysis' (Klein and Truex, 1995) of end-user's response regarding their initial and long term use of Moodle software. During Moodle implementation, the university nominated (voluntarily) 16 so-called Moodle champions who served as a focal point in their respective departments. These champions participated in different trainings prepared by Learning Resource Center (LRC). LRC staff, in addition to two system developers, is responsible for administrating and providing system support. With the permission of the LRC administrator, we were able to conduct in-depth interviews with 10 participants (8 Moodle champions, 2 Moodle developers) in the period of five month.

In their capacity, the participants could assess the appropriation process of Moodle among more than 1000 university staff and many students in the past year. When we carried out the interview, Moodle had been used for a period of time; thus the Moodle champions and LRC staff were interacting with both new as well as fairly experienced end-users.

3.1.1. Data Analysis

Data analysis was carried out with the objective of extracting empirical evidence that support holistic based IS design approach. Thus the content analysis process gave a particular focus for end-user's experience of ready to hand mode. In particular, we draw on the following steps:

1) We have transcribed all 10 interviews and uploaded them to Atlas.ti without modification.

2) We have coded the interviews at conversation level and looked for patterns. For example, different end-user's repeated response of "I used to feel home with the old technology" emerges as a pattern of *familiarity*. Some interview responses were applied to different patterns. In total, more than 35 pages of transcribed interviews were coded.

3) After finalizing the coding process, we read the coded sentences iteratively to merge pattern key words and find new ones, thus repeated step 2. One of the authors has re-read the interviewees responses to find additional new pattern key words by repeating step 2 and 3. Four main categories (families as it is termed in Atlas.ti) emerged (See Table 4).

4) Finally, through iterative reading, coding and search of texts and their contextual meaning, we have determined logical relationships of end-user's mode of appropriation in relation to our IS design principles.

Categories	Descriptions	Examples
Learning process	Users continue to discuss functionalities. User's participation to the new system subsidized as ready to hand gets its way.	"We are concentrated on just get up and running. Starting to see new things, we didn't have time yet".
Familiarity	User's look for familiarity in the new system that was possible to do in the old work system.	"I would like to have something similar to WebCT, since it felt home".
Work arounds and breakdowns	Users continue to use workaround in the face of breakdowns.	"There are several people who do workarounds. I have it as well, which I created before long time ago, from WebCT limitation, but I continue using it, in fact I adopted my old solution the new system. Workaround stick longtime may be even though you don't need them anymore".
worksystem	User's look for the application of different functions to their worksystem and even to their existing workarounds. Technology is becoming 'equipment' and withdrawn from attention, and tune with the existing worksystem.	"I think the system fits, I don't see any problem in the production of the software, but I think there is a need to make some changes to in the organization".

Table 2. Four Main categories of context based coding

3.2. Presentation of Findings

Based on our findings, this section presents end-user's technology-in-practice experience.

1) The learning process

After the implementation of Moodle, as our data shows, users were mainly concerned with locating technological properties that afforded them to do their daily activities. Many of Moodle champions responded to questions concerning functionalities that fulfill user's daily activities *("I used to get hands-on kind of question all the time like how do I upload my file, create a link or put up video"Tagged006)*. It is evident that Dasein's response to first time encounter of new technology is a present-at-hand mode. Even though, at the surface user's respond seemed a pure assessment of features of the new tool, we have also seen evidence that user's encounter was a ready to hand oriented one (*"I used to get question like 'would it be good if I can do this' then I would say, but yes you can do that" Tagged 004)*.

2) Familiarity

We have observed user's tendency of comparing the new tool with the old system *("But the question is more about the equivalent options they can get in Moodle" Tagged006).* Users had interacted with the old system (WebCT) in a ready to hand mode for more than 10 years which made the old system part of their daily activities. In fact, WebCT was no longer used as an IT artifact but as equipment entangled in the worksystem. Users were looking for not only technological features that resembles the WebCT but also all the socio-technical entanglements they were able to create with WebCT (*"I would like to have something similar to WebCT, since it felt home" Tagged008)*. The domain of application contains tacit knowledge and workarounds that cannot easily be retraced back to the technical part of IT system. For example, during Moodle trainings users asked for trainers who were familiar with their old way of

practice in WebCT. *("It could have been better if we had training from our people here, because we had some people from Umea (another university in north of Sweden). They work in another way with the system than our needs were. I think it could have been better if we had instructors who were more familiar with WebCT" Tagged007).* The hands-on experience in the same domain of application has turned out to be a critical issue for both user requirement elicitation and post-implementation processes.

3) Workarounds and breakdowns

We have also observed that workarounds play a critical role in achieving user's goal. More than half of the interviewees have witnessed end-user's continuation of using WebCT workarounds. For example, one user has adapted his old workarounds accordingly with the new system *("I have workaround as well, which I created long time ago, from WebCT limitation, but I continue using it, in fact I adapted my old solution (to) the new system. Workaround stick longtime may be even though you don't need them anymore" Tagged008).* As a result, the old system limitation continues to be part of the new domain of application. In addition, new system limitations creates new domain of application, where end-users make their own perceptual artifacts (workarounds) within or outside of the new system ("*Yes, of course, grading in excel file or importing to excel file. This is because I feel like more at home. I used to do that before in WebCT as well, so it is continued process. May be it is also feels good that you have the grades in your file inside your computer, so that you can manipulate the work as you want" (…) "Probably I will try to use moodle in the future, but I don't think I will do that" Tagged001).*

Our data also have shown that breakdowns are inevitable part of IT appropriation process. We have observed evidences that the implementation of Moodle requires some users to stop and think about their pedagogy routines. (*Some feel like they like the new (system) and take an opportunity to even change the course and do some major update about the course, so if you see it that way, they actually make changes as an opportunity for the course and the way they teach. So in a sense, it becomes a tool for them Tagged005 (…) "Moodle demands you to plan your course efficiently. I think when I work in moodle I have to have a map, so put some more effort to structure the course well. In that way, it is good" Tagged010)*. In some instances, breakdowns have provided an opportunity to improve work systems.

4) Work systems

Finally the data indicates that users started to embrace Moodle as a part of the existing work system, where it is used with less cognitive effort. Moodle champions started to get advanced questions about some features. *("But I also think that LRC start to get more advanced questions about different feature's (in Moodle) use"Tagged001*).

We have also seen some evidence that end-user's technology adoption and practice of engagement can be affected by other existing work systems, local circumstances and 'articulation of work history'(Gerson and Star, 1986) existing in the organization *("So when it comes to Moodle opportunities, should we use that? Then the question is what kind of effects it has on other personnel, like Ladok people (student's database) and secretaries, archivists, who use papers. Never mess with something that works well. So there are a lot of things when it comes to routines, not only here but inter-department worksystem" Tagged004*).

4. Analytical Discussion: Holistic ontology of IS design

In this section, we use end-user's responses to illustrate holistic IS design principles embedded in user's technology appropriation manner. In doing so, we associate IS design principles outlined in Table 1 with our findings. Note that, the principles are not intended to be used as 'hard and fast' rules in the process of ISD. Rather, they are proposed for reflection in developing standard holistic design methodology.

1) The principle of worksystem articulation

The first principle emphasizes that problem domain cannot be easily transformed to collection of operational ends. Dasein is *thrown* to holistic system where knowing-in-action is used as a common-sense response to daily activities. Other than due processes (organizational procedures), local knowledge and "learning by doing" (Schön, 1999), practices are Dasein's primarily practice of engagement. End-user's comments (*See 'learning processes and 'worksystem' categories*) imply that user's daily practice evolves in use and in negotiation. (See *Learning process and familiarity* Categories). In contrary to dualistic understanding of user's environment only as a problem domain, this principle indicates that the task environment encompasses solution domain. Our data have shown that users already know how the worksystem should work (*See learning process category*). Consequently, defining user's environment as 'problem domain' that has to be fixed by an outside IS knowledge base is inconsistence with Dasein's practice of engagement.

This principle is applicable, in particular, to the dimension of user requirement elicitation. The Cartesian view defines end-user's needs and domain of application through a few visits of a system analyst who interviews selective end users. A system analyst in such position misses 'average *everydayness'* (Dreyfus, 1990) such as articulation, local knowledge and practices, cognitive artifacts (workarounds) adopted by end users. Consequently, a system analyst characterizes Dasein's practice of engagement as a present at hand reflection of activities. Riemer and Johnston (2012) also found that user's accounts during such requirement analysis discussions are amounted to a present at hand response, which mainly echoes due processes (procedural workflows). Holistic IS design principles, thus, advocate end users participation in user requirement analysis and, where possible nominate system analysts working in the domain of application. Our argument is consistent with different IS design approaches such as participatory design (Schuler and Namioka, 1993), situated design (Garrett, 2010), contextual inquire (Holtzblatt and Jones, 1993) and other Scandinavian approaches (Ehn, 1993) that advocates greater end user's participation during IS Design.

2) The principle of worksystem representation

This principle concerns with the process of formulating user's environment in the form of abstraction. Dualistic approach develops such abstraction using techniques that usually include IS jargons, opaque terminologies and technology based constructs. System analyst's use of technological terms and constructs in representing a worksystem creates a communication gap between user's and IT designers (Alter, 2001). Both Dasein's present at hand and ready to hand encounters suggest that end users will look for familiarity and affordances during implementation and long term use of IT solutions based on their contextual background (See *Learning process and familiarity category*).

Consequently, IS research should prioritize developing methods and constructs of system analysis for non-IT professionals. The argument is that the process of formally representing a user task environment is not a "technical problem"; therefore technical means are not required to understand a task environment. We have already seen evidences where non-IT professionals were able to produce the same quality of user requirement documentations using MS-word templates as IT professionals (Truex et al., 2012). Such efforts are encouraging as it increases end user's participation in the design process and ultimately enables system designer to grasp contextual business problems.

3) The principle of breakdown

From holistic perspective, problems arise in relation to a situation as a background; thus it is implausible to fully 'objectify' a given problem. A holistic approach views Dasein's situation of "interrupted moments" of everydayness as breakdowns. The concept of breakdown plays a fundamental role in revealing Dasein's ready to hand activities. Some of our interviewees have experienced such a breakdown that resulted in a reflection on their ritual pedagogies (*See Work arounds and breakdowns category*). The principle of breakdown can be applicable, in particular but not limited to, in the dimension of 'abstraction to computer representation' IS design phase in the following ways:

A) Structural coupling: Contrary to dualist objective of developing a 'perfect system', IS practice is full of negotiations and breakdowns. Dasein's present at hand response to breakdown is structural coupling (Maturana and Varela, 1980), which involves learning and adaptation. A good computer system not only builds on the notion of breakdowns but also inspires and accommodates such emergent changes.

B) Hermeneutic methodology: Unlike dualistic emphasis on subject to object relationship during IS design, the IS practice is based on subject to subject relationship; which Giddens (1982) referred to as "double hermeneutic". In other words, user's social relations, daily negotiations and interpretations of flow of work are as important as procedural workflows. Hermeneutic method of analysis aims at 'sense making' (Weick, 1988) of user's daily activities that include 'IT, organizational workflows and people'(Myers and Klein, 2011). Using hermeneutic as 'mode of analysis' (Myers and Klein, 2011) can assists in grasping contextual meaning of user's daily activities. Domain of application is better understood if such contextual meanings are embodied in formal representation of user requirement in computer structures.

C) Anticipation of breakdown: Holistic ontology sees IS design as a *process*, not as a onetime task that results in a finished work. Consequently, holistic IS design concerns with developing ways of managing continuous design and breakdowns. It is almost impossible to predict all breakdowns. It is possible, however, to develop computer level structures that incorporate standard means of reporting breakdowns. For example, our case study has shown that users were not able to report their struggle in a transparent way. *("Process from the (users) is not usually specific. For example, they goes like Facebook works better, but they don't say what is they need that is similar to Facebook that needs to be there" (…) "requests are coming constantly, but the process is not clear in all cases." Tagged002*).

4) The principle of system thinking

The forth principle concerns with the domain space that a system analyst creates using IT artifact. Dualism advocates that objective knowledge of reality is attainable and can be fully represented using

material properties. As we have seen in principle one, human 'everyday practice' involves common sense actions and intuition that cannot be formulated or captured as material properties. Thus, dualistic ontology based artifacts cannot avoid blindness that comes with the inability to include Dasein's everydayness in the domain space. In addition, Winograd and Flores (1986) examined blindness created in domain space as a result of system analyst's own contextual background that influenced the formulation of task environment and development of technological artifacts. Consequently, a design that is based on a priori knowledge is exposed to *blindness*.

Since dualistic ontology aims to attain a perfect fit with task environment, task characterization passes through different series of IS design steps. Such series of steps, which sometime include complex engineering methods (Truex et al., 2000), achieve the opposite effect of what dualist ontology aims for. This means that each series of steps increases the number of blindness as each of them creates more chances of losing Dasein's 'average everydayness' (Dreyfus, 2000). Holistic ontology avoids demarcating domain space in to series of steps in order to understand problem domain. One way of achieving such goals is to follow methods that accommodate amendable domain space. In this regard, efforts such as the theory of tailorable technology can be used as an example where priori reason has a limited effect on deciding on the domain of application (Germonprez et al., 2007).

The following table relates IS design principles embedded in dualistic and holistic ontologies:

IS design steps	**Dualistic IS design principles**	**Holistic IS design principles**
Defining problem domain and user requirement	Problems exist in worksystem and solution are in IS knowledge base. Domain space is definable as a collection of operational ends. Worksystem can be analyzed in Present at hand mode.	Both solution and problems are in the worksystem. Best practice is emergent and tacit. System Analysts should work in the domain of application.
Formal representation of user requirement	Creating instrumental problems. IS jargons and methods. Imposing boundaries.	Defining problems is not a 'technical problem' in itself, search procedure is. Worksystem representations.
Abstractions to computer representation	Impoverished possibilities of modeling and representation of breakdown and workarounds. Providing solution to improve IT systems	Structural coupling. Hermeneutic methodology. Breakdowns as a revealing best practices opportunity. Providing solution to improve work system.
Search procedures	Fit logic Creates blindness. Present at hand domain of application. IT artifacts, instantiations, methods and constructs.	Holistic domain of application. Target to improve worksystem. Application of domain space anticipates potential breakdowns. Equipment

Table 3: Analytical summary of Dualist and Holistic IS design principles

Conclusion

This paper explores the possibility of applying a holistic ontology to develop material artifacts. Dualistic ontology strongly informs contemporary IS design principles that advocate high-level of rationality in IT artifacts, system requirements and specification analysis, as well as ISD methods. Using Heidegger

equipment analysis, we have shown that a holistic ontology tells a convincing IS practice story from which realistic IS design principles can be derived. Based on holistic ontological stance, we then have extracted contingent IS design principles. We presented a case study that demonstrates logical relationship between end-user's IS practice and holistic IS design principles.

Our study contributes to the IS literature in various ways. First, we address the notion of holistic based IS design principles and their possible application in different IS design dimensions. We are not claiming that these principles should replace existing dualistic approaches. Instead we demonstrate how ontological level stance affects operational level of IS design approach. Second, based on our case study, we demonstrate the concept of breakdown and its contribution for the improvement of worksystem. Emergences of breakdowns can be used as a tool for revealing best practice. Third, we have shown that IS design method that follows a fit logic creates a necessary condition to adopt a new technology, but not a sufficient condition to improve a worksystem. Finally, we highlight the use of IT systems as a 'platform' to generate a better worksystem in organizations. In this regard, holistic ontology contributes to ongoing IS research such as 'design for thinking' (Brown, 2008), secondary design (Germonprez et al., 2011) and the theory of tailorable technology (Germonprez et al., 2007) research.

Further research work is needed to see the implication of holistic IS design principles for managers. In addition, our case study did not allow us to discuss one of the core IS design issue - evaluation. We believe that the principle of system thinking gives a 'provision for continuous evaluation' (Weick, 1977) and future studies can complement such enquires.

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