芽|Sprouts Working Papers on Information Systems ISSN 1535-6078

Using Information Systems Effectively: A Representational Perspective

Andrew Burton-Jones
University of British Columbia, Canada

Camille Grange
University of British Columbia, Canada

Abstract
Although there has been a great deal of research on why individuals adopt and use information systems, there is little research on what it takes for individuals to use information systems effectively. Motivated by the view that much of the impacts of information systems stem from how they are used, we propose a model to explain the nature and drivers of effective system usage. The model is designed to explain effective system usage in the context of an individual user employing any individual information system. In this context, we build on a theory of information systems known as representation theory to propose that effective system usage requires a user to engage in three activities: adaptation activities (adapting the system so that it provides better representations), learning activities (learning how to access the representations offered by the system), and verification activities (verifying the representations in the system as well as the real world domain being represented). The model suggests a set of factors that drive these activities, specifies how these activities drive effective usage, and proposes a link between effective usage and usersâ task performance. After specifying the model, we provide examples of how it could be used to explain the effective use of several types of information systems and we discuss how the model could be expanded to explain other contexts of use (e.g., multiple systems and multiple users) and to incorporate process forms of theorizing as well as variance forms of theorizing.

Keywords: effective system usage, performance, representation theory, system structure

Permanent URL: http://sprouts.aisnet.org/8-21

Reference: Burton-Jones, A., Grange, C. (2008). "Using Information Systems Effectively: A Representational Perspective," Proceedings > Proceedings of JAIS Theory Development Workshop . *Sprouts: Working Papers on Information Systems*, 8(21). http://sprouts.aisnet.org/8-21

USING INFORMATION SYSTEMS EFFECTIVELY: A REPRESENTATIONAL PERSPECTIVE

ABSTRACT

Although there has been a great deal of research on why individuals adopt and use information systems, there is little research on what it takes for individuals to use information systems effectively. Motivated by the view that much of the impacts of information systems stem from how they are used, we propose a model to explain the nature and drivers of effective system usage. The model is designed to explain effective system usage in the context of an individual user employing any individual information system. In this context, we build on a theory of information systems known as representation theory to propose that effective system usage requires a user to engage in three activities: adaptation activities (adapting the system so that it provides better representations), learning activities (learning how to access the representations offered by the system), and verification activities (verifying the representations in the system as well as the real world domain being represented). The model suggests a set of factors that drive these activities, specifies how these activities drive effective usage, and proposes a link between effective usage and users' task performance. After specifying the model, we provide examples of how it could be used to explain the effective use of several types of information systems and we discuss how the model could be expanded to explain other contexts of use (e.g., multiple systems and multiple users) and to incorporate process forms of theorizing as well as variance forms of theorizing.

Keywords: effective system usage, performance, representation theory, system structure.

INTRODUCTION

Arguably the most concentrated area of research in information systems over the last twenty years has been the study of why people adopt and use information systems (Benbasat and Barki 2007). Such research is motivated by the belief that organizations and their employees can reap many benefits from information systems, but to do so, systems "must be accepted and used" (Venkatesh et al. 2003, p. 426). Although getting systems accepted and used will always remain a critical problem, Jasperson et al. (2005) suggested that a bigger problem faced by organizations today is improving *how* information systems are used. In other words, in addition to getting people to use an information system, managers need to know how to get people to use information systems effectively. Thus, in recent years, researchers have been increasingly interested in moving "from the study of use (i.e., IT adoption and use) to the study of effective use…." (Marcolin et al. 2000, p. 52). This shift is critical for practitioners too, given that many firms now spend over 50% of their capital expenditure on IT systems (Meeker et al. 2007).

Because of researchers' attention in the past on acceptance and use, rather than effective use, there is little research on what leads people to use systems effectively (Venkatesh et al. 2003, p. 470). Table 1 outlines the main contributions to this stream of research (to our knowledge) to date. As the table shows, researchers have generally focused on identifying: (1) *types* of use that increase users' task performance, or (2) *contexts* in which systems usage increases users' task performance (e.g., when an IS fits the task and when users are competent).

Table 1: Existing studies on performance-enhancing use of information systems

Focus of study	Description	Representative studies
Type of use		
Faithful use	Users' task performance will increase when they employ an IS faithfully, i.e., consistent with its original intent.	DeSanctis and Poole 1994, Chin et al. 1997

Exploitive and exploratory use	Users' short-run task performance will increase if they exploit their knowledge of the IS; their long-run performance will increase if they exploit their knowledge of the IS and explore new ways of using it.	Subramani 2004, Burton-Jones and Straub 2006
Applied and adapted use	Users' task performance will increase when they apply IS in their tasks and when they adapt the IS and adapt themselves (through learning).	Barki et al. 2007
Effective use	Users' task performance will increase if they employ ISs effectively in their tasks.	Pavlou and El-Sawy 2006, Pavlou et al. 2008
Quality use	Users' task performance is affected by the quality with which they employ the IS	Boudreau and Seligman 2005
Context of use		
Task-technology fit	System usage (and faithful usage) will increase users' task performance if the IS fits the task.	Goodhue and Thompson 1995, Dennis et al. 2001, Devaraj and Kohli 2003, Ahearne et al. 2008
User-task-technology fit	System usage will increase users' task performance if the IS fits the task and the user is sufficiently competent to use it.	Marcolin et al. 2000

Although these studies have contributed to our understanding of effective system usage, there remains several ways that advances in the area need to be made. In this light, our research has two motivations. Pragmatically, we wish to fill a gap in past research by proposing a model that identifies the nature and drivers of effective system usage for information systems in general. Past research has generally focused on the nature *or* drivers of effective usage, not both. Specifically, studies that have focused on the *context* of use have identified contexts that enable effective use, but they have not conceptualized what effective system actually involves in such contexts. For example, user-task-technology fit theory (Marcolin et al. 2000) proposes that users will use a system in a way that increases task performance if the system fits the task and if the user is competent. However, the theory could be made more complete by proposing how researchers could verify whether systems are actually being used *effectively* in these contexts.

Likewise, studies that have focused on *types* of use have helped us understand what effective usage involves, but only a few have studied what drives effective use. For example, most studies of this type in Table 1 only examine the effects of system usage, not its drivers (Chin et al. 1997, Subramani 1994, Burton-Jones and Straub 2006, Barki et al. 2007, Pavlou and El-Sawy 2006). DeSanctis and Poole (1994) identified many drivers, but left an explanation of which would be most important to future research, simply proposing that the way users employ systems "may vary depending on the task, the environment, and other contingencies…" (p. 128). Only two studies to our knowledge have examined specific drivers. Boudreau and Seligman (2005) proposed that the quality with which users employ an ERP system at time 2 is a function of the quality with which they used it at time 1, their perceptions of the system at time 2, and the extent to which they took actions to learn the system between time 1 and 2. Pavlou et al. (2008) proposed that users will employ collaboration systems effectively if they perceive them to be useful, easy to use, customizable, if they trust their group members, if their use of the system is a habit, and if the environment is uncertain. Both of these studies reported results supporting their propositions, which suggests that it is possible to explain the drivers of effective usage and opens up an opportunity to do so for information systems in general rather than just specific types of IS, such as ERP systems or collaboration systems.

In addition to this pragmatic aim, our research is driven by an idealistic aim: to develop a model of effective usage that takes seriously the unique nature of information systems. Many researchers have lamented how rarely we consider the unique nature of information systems in our work (Orlikowski and Iacono 2001, Benbasat and Zmud 2003, Wixom and Todd 2005, Leonardi 2007). Perhaps the bluntest example is Weber's (2004) *MISQ* editorial in which he argued that many theories in our field regarding peoples' interactions with information systems could equally be used to explain how people interact with their toothbrushes. While perhaps extreme, his argument has merit. For example, Burton-Jones and Straub (2006) suggested that people will improve their task performance if they exploit their knowledge of the IS when using it. Presumably, people will also improve their dental hygiene if they exploit their knowledge of toothbrushes when brushing. The same argument could be made regarding task-technology-fit theory and other theories in our field. Our aim is not to criticize past research on this account, but to take such criticism as a challenge to develop a model that accounts for the unique nature of information systems. Like Wixom and Todd (2005), we wish to do so in a way that can "apply broadly across a wide range of systems" (p. 100) so that the model can support a wide range of research and complement research on specific types of systems. We recognize that this motivation is somewhat idealistic because it may turn out that a general, non-IS theory such exploitation/exploration will explain effective system usage more powerfully than a theory unique to information systems. This will be an important empirical question.

At the outset, we should note the meta-theoretical assumptions underlying our work. First, we adopt *positivist* assumptions. Like Hovorka et al. (2008, p. 36), we use 'positivist' in a broad sense to refer to research interested in hypothesis testing, measurement, and validity; not logical positivism. Following a positivist approach, our model consists of constructs that we think reflect the nature and drivers of effective usage (rather than constructs that necessarily reflect the way that users in practice think of effective usage, Lee 1991). Second, our model attempts to *explain* the nature and drivers of effective usage rather than to interpret how effective users work (as in interpretive research) or to emancipate users from constraints they face (as in critical research) (Orlikowski and Baroudi 1991). Third, our model utilizes a *variance* form of theory (Markus and Robey 1988). This is to scope our work; we explain later how our model could be extended via process-oriented theorizing. Given these assumptions, we should note that several studies of system usage have been undertaken by researchers with other assumptions, especially interpretive, process-oriented assumptions (Orlikowski 2000, Boudreau and Robey 2005, Vaast and Walsham 2005, Leonardi 2007). They have generally focused on understanding how system usage affects organizational change rather than task performance. Even so, they have discovered important insights that we draw on in building our model.

Our paper is structured as follows. In the next section, we describe a theory of information systems known as “representation theory” and we explain its implications for effective system usage. We then draw on these implications to propose a model of the nature and drivers of effective usage. We then present examples of how the model could be used to explain the use of three different types of information systems (reporting systems, planning systems, and recording systems). In the penultimate section, we describe how our model could be extended to (1) explain effective system usage when there are multiple users and multiple systems, and (2) to include a process-oriented perspective as well as a variance-oriented perspective. We conclude by discussing limitations of our work and its implications for research and practice.

REPRESENTATION THEORY

One way to conceptualize what effective usage involves is to identify the *function* of information systems. This is because if we know the function, we can conceptualize effective usage as that type of usage that improves the effectiveness with which the function is attained. Pavlou and colleagues (Pavlou and El-Sawy 2006, Pavlou et al. 2008) have adopted such an approach to develop measures of effective usage for specific types of systems. For example, if the function of a collaboration system is to enable collaborative work, the effective use of a collaboration system can be measured by asking users the extent to which they use the system effectively to “work with others in real time” (Pavlou and El-Sawy 2006, p. 223). Likewise, if the function of a project management system is to enable managers to monitor and track projects, the effective use of a project management system can be measured by asking users the extent to which they use their system effectively to “visualize and monitor project status…” (ibid).

In this paper, we wish to extend such an approach to conceptualize and measure effective system usage for any type of information system. The challenge in doing so is to identify a general function of all information systems. This is difficult because information systems often have multiple, and at times contested, functions, e.g., to support workers while controlling them and rendering them substitutable (Orlikowski 1991). Perhaps because of this difficulty, few researchers have proposed a general function for all information systems. One set of researchers to have done so is Wand and Weber (1990, 1995). According to them, information systems exist because "it is the human condition to seek better ways to understand and to represent the world" (Weber 1997, p. 59). That is, while information systems may be used for many task-specific reasons (e.g., computational assistance, enjoyment, power and control, and so on), the basic function of *all* information systems is that they help individuals to understand the states of some real world systems that are relevant to them, such as the states of their mind, states of their organization, or states of the organization's environment. Weber (2004) writes:

> … "representation" [is] the essence of all information systems. The raison d'etre for information systems [is] that they track states of and state changes in other systems. By observing the behavior of an information system, we obviate the need to observe the behavior of the system it represents…. For example, with an order-entry information system, we track states of and state changes in customers, which means that we do not have to consult with each customer individually to determine the goods or services they wish to purchase. Moreover, in some cases an information system provides us with the only means we have available to observe the behavior of the represented system. For example, in a simulation, the represented system may not exist, except in our minds" (p. viii).

Although Wand and Weber's representation theory is not used often in mainstream IS research, some IS researchers have used the idea that information systems provide representations in studies of IT-impacts (Ruhleder 1994), knowledge management (Walsham 2005), semiotics (Stamper et al. 2000), virtual work (Robey et al. 2003, Overby 2008), and philosophy of IS (Sesé et al. 2006). This idea also plays an important role in fields closely related to IS such as artificial intelligence (Davis et al. 1993), database systems (Kent 2000), human computer interaction (Suchman 1995, Bodker 1998), and organizational design (Yoo et al. 2006).[1]

[1] We should point out that whereas we use the term 'representation' to refer to representations offered by an IS, it can also be used to refer to the way that people represent themselves and their ideas to other people (Vaast and Walsham 2005). Integrating these different ideas lies outside the scope of our work.

Wand and Weber applied their work on representations initially to just one topic: conceptual modeling (Weber 1997). However, researchers have recently begun to extend their theory to explain a broader range of phenomena, such as organizations' decisions to replace their IS (Heales 2002) and organizational-IT alignment (Rosemann et al. 2004, Sia and Soh 2007). In a similar vein, we extend their work to explain the nature and drivers of effective system usage.

In developing their representation theory, Wand and Weber suggest that any information system can be viewed as comprising three structures (see Figure 1): deep structure (the data, rules, and functions in a system that represent states, laws, and functions in the world, e.g., the communication exchanges, messaging protocols, and messaging features in an email program); surface structure (the facilities that allow users to access the representations of a system, e.g., the user interface of an email program); and physical structure (the physical machines that support the surface and deep structure, e.g., laptop computers, cell phones, digital assistant devices, and their networks via which a user can access email) (Weber 1997, pp. 78-80).

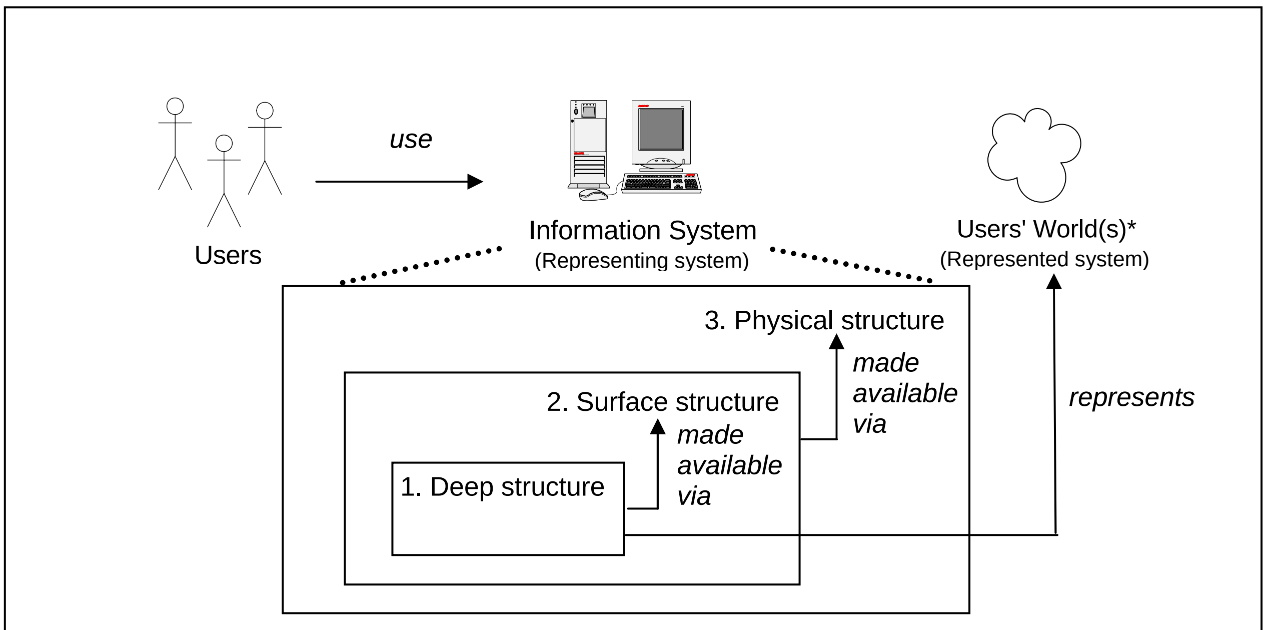

Figure 1: Information Systems: Deep, Surface, and Physical Structures

* Although the phrase "users' worlds" in this figure is somewhat abstract, we use it because the real world systems represented by the information system are socially constructed.

We propose that Wand and Weber's representation theory has three implications for measuring effective usage that stem from the distinction between the three structures of a system and the truism that any representation of the world (and any user's understanding of the world) will inevitably be partial and fallible (Suchman 1995, Kent 2000):

- Adaptation: Because any representation offered by a system will be partial/fallible, users must adapt their systems and/or their use of the systems to overcome these limitations.
- *Learning*: Because deep structure is made available via surface and physical structures, users must learn to access the deep structure unimpeded by these other structures.
- *Verification*: Because any representation offered by a system will be partial/fallible and any user's understanding of the world will be partial/fallible, users need to verify the validity of both the representations offered in the system and their own understanding of the world so that they can use and adapt a system appropriately.

We next draw on these implications to propose a model of effective usage. Although adaptation and learning activities have been noted in past studies of usage (Boudreau and Seligman 2005, Barki et al. 2007), we are not aware of any theory that has paid attention to all three issues.

THE NATURE AND DRIVERS OF EFFECTIVE SYSTEM USAGE

Figure 2 shows our model and Table 2 defines each construct. Before discussing each part of the model, it is important to note that we limited the model to constructs that flow directly or indirectly from representation theory. Representation theory states that the reason why information systems exist is to provide representations, that good systems provide faithful representations (Weber 1997, p. 73), and that an IS provides its representations (its deep structure) via surface and physical structure. If the theory is correct, it suggests that systems that provide users with more faithful representations in a more efficient manner will help users more in their tasks. Accordingly, from a functional perspective (as outlined earlier), we conclude that effective usage is that type of usage that *improves users' ability to obtain faithful representations from the IS*. We suggest that users' ability to do so at any point in time is a function of (a) the extent to which the representations in the IS are sufficiently faithful for the task in which the IS is being used (which we term 'fit-in-use'), and (b) the extent to which the user can access the deep structure via its surface and physical structure (which we term 'transparent interaction'). Because systems vary in the fidelity of their representations and the accessibility of their deep structure, we suggest that the extent to which the user can achieve these aims is a function of (a) the fidelity of the representation offered by the IS, (b) the complexity of the system's structures, and (c) the users' ability to engage in the three actions noted earlier (i.e., adaptation, learning, and reality verification). These arguments account for all the constructs in our model (Figure 2). We recognize that many other factors could drive effective usage (e.g., users' motivation to perform certain actions, and their intelligence). We do not include such factors in the model because they do not flow from representation theory. Rather, we wish to propose a cohesive model that draws on and allows us to test the usefulness of representation theory. We discuss each part of the model in turn in the following subsections.

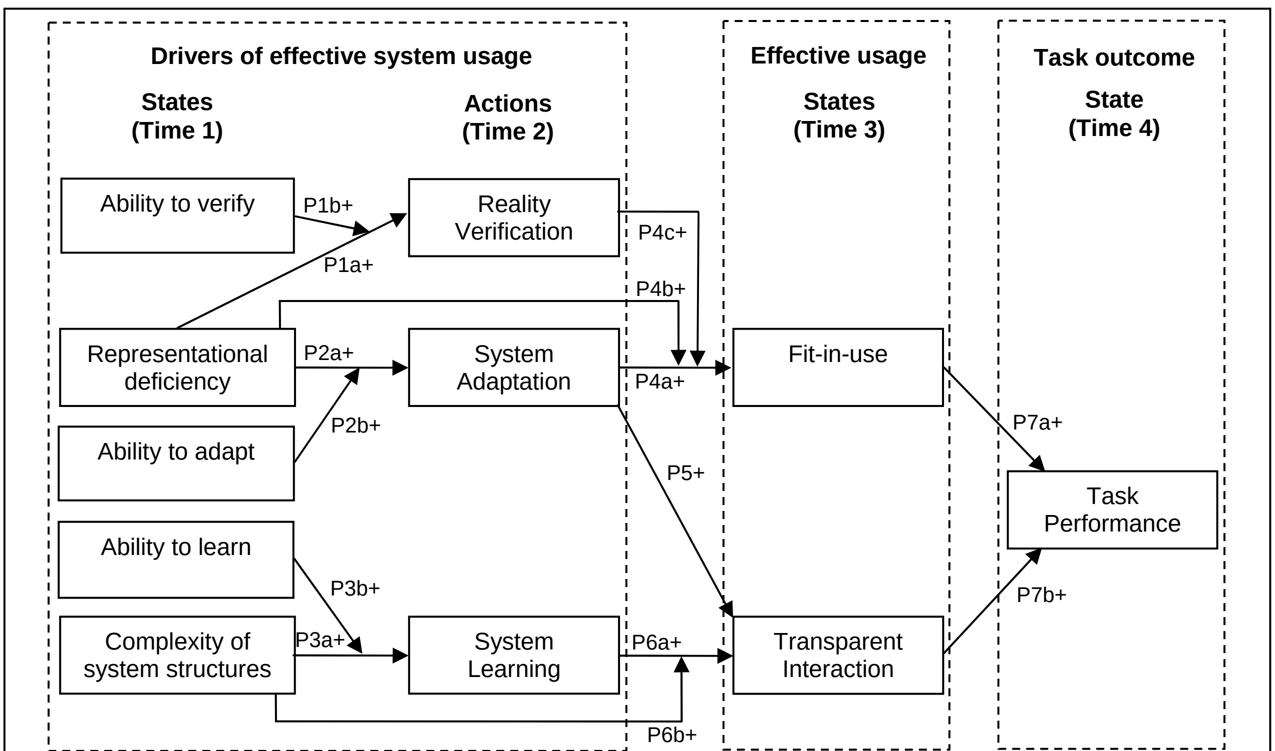

Figure 2: Theoretical Model

Table 2: Construct Definitions		
Construct	**Definition**	**Related references**
Ability to verify	The extent to which the user can verify his/her understanding of the domain and the fidelity of the representations in the IS (e.g., whether s/he has sufficient resources available to verify them).	Griffith 1999, Mathieson et al. 2003, Butler and Gray 2006
Representational deficiency	The extent to which the system provides a view of the real world system that is less complete, clear, meaningful, and correct than would be obtained if the real world system was observed directly.	Wand and Wang 1995
Ability to adapt	The extent to which the user can adapt the system (e.g., whether s/he has sufficient knowledge and time) and the extent to which the IS can be adapted (e.g., whether its structures are flexible).	Marcolin et al. 2000, Orlikowski 2000, Ahuja and Thatcher 2005.
Ability to learn	The extent to which the user can learn the system (e.g., whether s/he has sufficient resources available to learn its structures).	Nambisan et al. 1999; Mathieson et al. 2003
Complexity of system structures	The extent to which the structures of the system: (a) have many elements, (b) have elements that are tightly coupled to each other, and (c) have elements that are dynamic (i.e., change).	Wood 1986, Yourdon 1989
Reality verification	The extent to which the user engages in actions to verify: (a) the representations in the IS, and (b) his/her understanding of the world. Such actions can involve: (a) verifying states in the world directly, (b) verifying other representational mechanisms, or (c) attending to advice from people with knowledge of the domain.	Griffith 1999, Swanson and Ramiller 2004, Butler and Gray 2006
System adaptation	The extent to which the user engages in actions to adapt the IS or their use of it so that it provides representations more effectively or efficiently. Adaptations can be made to deep structure (to alter the representation) or surface and physical structure (to improve access to the representation). Users can adapt the IS directly or indirectly (e.g., via placing change requests with IT staff).	Orlikowski 2000, Majchrzak et al. 2000, Boudreau and Robey 2005, Barki et al. 2007
System learning	The extent to which the user engages in actions to learn the representations offered by the system and how to access them. This could involve exploring or experimenting with the system itself or learning from other users with more experience with it.	Boudreau and Robey 2005, Spitler 2005, Gallivan et al. 2005, Barki et al. 2007
Fit-in-use	The extent to which the user interacts with the representations offered by the IS in a way that fits the requirements of his/her task.	Goodhue and Thompson 1995, Davern 1996, Barki et al. 2007
Transparent interaction	The extent to which the user interacts with the deep structure of the system unimpeded by its surface and physical structure.	Lave and Wenger 1991
Task performance	An assessment of task outputs in terms of effectiveness.	Sonnentag and Frese 2002

The Drivers of Effective System Usage: States and Actions

As Figure 1 shows, we propose that effective usage is driven by three actions (reality verification, system adaptation, and system learning) that are driven by three states of the user (ability to verify, adapt and learn) and two states of the system (representational deficiency and complexity of system structures). We offer three propositions regarding these drivers.

Proposition 1: *The greater the representational deficiency of an IS, the more that users will engage in reality verification (**P1a**). This relationship will be stronger when users are more able to engage in reality verification (**P1b**).*

The logic of Proposition 1 is as follows. We propose that the primary trigger to engage in reality verification is the representational deficiency of the IS. Specifically, the poorer the representation (i.e., the less complete, clear, meaningful, and correct the representation, per Table 2), the more likely the user is to check its validity (**P1a**). For example, if a customer representative knows that the inventory system contains poor data, he will be more likely to call a staff member in the inventory warehouse to check whether there really is enough inventory when a customer places an order rather than just rely on the numbers in the database. However, the user's ability moderates this relationship by acting as an anchor. When users have great ability to engage in reality verification (weak anchor), representational deficiency will drive the extent of reality verification, but when users have little ability to engage in verification (strong anchor) (e.g., if the customer representative has no contacts he can call in the warehouse), reality verification will likely be low regardless of the level of representational deficiency (**P1b**).

Proposition 2: *The greater the representational deficiency of an IS, the more that users will engage in system adaptation (**P2a**). This relationship will be stronger when users have more ability to engage in system adaptation (**P2b**).*

This proposition is similar to P1. The primary trigger to engage in system adaptation is the representational deficiency of the system. That is, the poorer the representation offered by the IS, the more likely that users will engage in actions to improve it or else workaround its limitation by adapting how they use it (**P2a**). Boudreau and Robey (2005, p. 13) cite many examples of this in their study of how employees used an ERP system in a university. In one example, there were not enough fields in the IS to record important data (specifically, credit card payments). To overcome this problem, staff members devised a work-around by adapting their use of one of the other fields in the system (a field for statistical codes) to record the data they needed.

Although all information systems can be adapted (Brooks 1987, p. 184), some are known to be very adaptable (e.g., Lotus Notes) whereas others are much more rigid (e.g., SAP) (Orlikowski 2000, Boudreau and Robey 2005). Thus, the user's ability moderates this relationship by acting as an anchor. When users have great ability to adapt the system or their use of it (weak anchor), representational deficiency will drive the extent of adaptation, but when users have little ability to engage in adaptation (strong anchor) (e.g., due to a rigid system or rigid work procedures), adaptations will likely be low regardless of the representational deficiency (**P2b**).

Proposition 3: *When the structures of a system are more complex, users will engage in more system learning activities (**P3a**). The relationship between system complexity and system learning will be stronger when users have more ability to learn the system (**P3b**).*

Proposition 3 follows the same structure as the prior propositions. We propose that the primary trigger to engage in system learning is the complexity of the system structures. Specifically, if a user is given a simple system, s/he will have little need to engage in learning activities. However, the more complex the surface, deep, or physical structure of the system, the more the user will have to learn these structures to operate the system (**P3a**). For example, assume that a sales analyst has access to a Microsoft Access database that she can use to analyze patterns in customers' purchasing behavior. If the interface to the database (surface structure) contains just a few icons for the queries that she can run, she will have little need to learn how to use it. However, if the user must use a visual query wizard to construct her queries, she will first have to learn how to use the wizard (e.g., learning how to identify the tables she wants to query and constructing joins between the tables). Likewise, if the customer purchasing information (deep structure) is simple, she will have little need to learn it. However, if there are many different products, customers, regions, time periods and so forth, she may have to spend substantial time learning about the domain to understand what data to query. Finally, if the device that she uses to query the system (physical structure) is simple, she will have little need to learn how to operate it. However, if the device is complex (e.g., if the user has to connect through a firewall and has to consider capacity limitations on the client, server, or network), she will have to spend time learning these matters if she is to use the IS.

As in P1 and P2, users' ability acts as an anchor, moderating the relationship between complexity of system structures and system learning. When users have sufficient resources to engage in learning (weak anchor), the complexity of system structures will have a strong effect on the extent to which the user engages in learning. However, if users have few resources available for learning (e.g., no colleagues they can ask about the IS, no time to engage in exploration activities, and no system documentation to help the user learn the system), then users will likely engage in little or no learning irrespective of the complexity of the system (**P3b**).

Explaining Effective System Usage

We offer three propositions regarding the effects of our antecedents on effective usage.

Proposition 4: *System adaptation (of deep structure) will improve fit-in-use (**P4a**). This effect will be more positive when the information system has greater representational deficiency (**P4b**) and when the user undertakes more reality verification (**P4c**).*

The dependent variable in Proposition 4 is fit-in-use. Traditionally, IS researchers have thought of task-technology-fit as a variable that exists prior to (and that affects) the use of the system. Recently, Barki et al. (2007) noted that task-technology fit could also be seen in a more dynamic fashion as something that occurs in use. That is, rather than assess how an IS fits a task prior to use, we can assess the extent to which a user employs the IS in a way that fits the task. This is what we refer to in our study as fit-in-use. The primary driver of fit-in-use in our model is system adaptation. We make this proposition because *all* representations are partial and fallible (Suchman 1995, Kent 2000) but better information systems provide more *faithful* (i.e., higher fidelity) representations (Weber 1997, p. 73). Because no representation is perfectly faithful, there will always be opportunities to improve the IS by improving the faithfulness of its deep structure. We propose that the main way to do so is via adapting the deep structure (**P4a**). If the IS is flexible, such adaptations can be made directly (e.g., a user might change the structure of a Lotus Notes database that she uses, Orlikowski 2000). If the IS is rigid, adaptations may be made indirectly (e.g., a user might send a change request to the IT department to alter the ERP's database, Barki et al. 2007) or via adapting the way the deep structure is used (e.g., a user may change the way she uses existing fields in the database, Boudreau and Robey 2005).

Although all representations can be improved, some representations are better than others. Thus, representational deficiency is a moderator. When the representation is deficient, it is likely that adaptations will improve fit-in-use, but as representational fidelity improves, adaptations are likely to have fewer benefits. When fidelity is already very high, adaptations may even begin to have costs (e.g., when users adapt a new IS so that it can work in the same way as a worse but more familiar prior system) (Beaudry and Pinsonneault 2005) (**P4b**).

The second moderating factor is reality verification. Specifically, the more that users engage in reality verification, the more likely they are to understand what needs to be adapted and why, and thus their adaptations are more likely to improve fit-in-use (**P4c**). For example, consider a consulting firm that allows analysts to select various databases to load onto their Lotus Notes desktops, such as repositories of proposals from past consulting projects and discussion databases in which consultants can discuss techniques for winning new work. Consultants who have engaged in more activities to verify which databases contain the best knowledge (e.g., whether the database of past proposals are likely to be relevant to new jobs and whether the people who contribute to the discussion database are offering useful knowledge) will likely load the more relevant databases onto their machines and use them more appropriately in their work. Haas and Hansen (2005) give a nice example of how consultants sometimes fail to do this. In their study, many consultants simply used databases containing past proposals without verifying the relevance of these proposals for new work; it turned out that reusing past proposals actually reduced the novelty of new proposals, leading them to win fewer jobs.

Proposition 5: *System adaptation (of surface and physical structure) will improve transparent interaction.*

The dependent variable in Proposition 5 is transparent interaction. Transparent interaction characterizes the way an individual uses a system when his/her interaction with the deep structure is unimpeded by its particular configuration of surface and physical structure. The term 'transparent' was coined by Lave and Wenger (1991), to imply, in its simplest form, that (p. 102) "the inner workings of an artifact are available for the learner's inspection…" We use the term in a similar way to suggest that the user can see 'through' the physical structure (available devices) and surface structure (interfaces) to interact seamlessly with the deep structure. In this light, note that many studies of usage define the 'IS' being used as a specific instantiation of surface and physical structure (e.g., a handheld PDA, Meister and Compeau 2002). But, this may be just one way of accessing and using the deep structure on the PDA (e.g., the contact database and calendar functions). For example, the user could also access this deep structure via other devices (e.g., a client PC or a mobile phone). Likewise, on any one device, the user may be able to access the database and functions via different software (e.g., MS Outlook or via Webmail) and in each case via different interfaces (e.g., via system shortcuts or via interacting with several menu options). Often, different configurations of surface and physical structure will vary in the extent to which they enable the user to interact transparently with the deep structure.

The logic of Proposition 5 is that in addition to adapting a system's deep structure to improve fit-in-use (per P4), users can also adapt surface and physical structure to improve transparent interaction. In the context of representation theory, the surface and physical structure of an IS are only important to the extent that they facilitate interaction with the deep structure. For example, consider a user who interacts with a sales reporting package. In terms of surface structure, a user might change the form of output used by the package from tabular to graphical to allow her to understand trends in the data or might add shortcuts to the menu to giver her faster access to reports. In terms of physical structure, the user might change the RAM in her computer to allow her to run computationally intensive reports faster or might change the size of her monitor to allow her to read large reports more easily. In all of these cases, the adaptations would help the user to understand and interact with the deep structure in a faster and more direct fashion (e.g., graphs display trend information more efficiently than tables, Vessey 1991, delays can cause people to lose track of what they are doing, Galletta et al. 2006, and larger computer screens help people find and read output more easily, Simmons and Manahan 1999).

Proposition 6: *System learning will improve transparent interaction (**P6a**). This effect will be more positive when the IS has more complex system structures (**P6b**).*

The logic of proposition 6 is as follows. First, we assume that all information systems are sufficiently complex that they offer opportunities for learning (Johnson and Marakas 2000). By engaging in learning activities, users can increase their understanding of their information system and thereby attain more transparent interaction with it (**P6a**). For example, consider a researcher running his statistics with SPSS. Such a user might undertake several activities to learn the surface structure of the system, e.g., learning how the command line interface works and learning useful short-cut keys to execute commands. He might also undertake activities to learn the deep structure, e.g., using descriptive statistics to understand his data and using the on-line help function to learn statistical functions. Finally, he might spend time learning the physical structure, e.g., investigating graphical software that can integrate with SPSS to display statistical output more clearly. In all of these cases, the learning activities would help the user to get closer to his data, his statistical tests, and the meaning of the statistical output (rather than being distracted by a lack of understanding of the system's surface, deep, or physical structure).

Although all systems offer opportunities to engage in learning, more complex systems offer more opportunities and requirements to do so (**P6b**). If a system is quite simple (e.g., a simple calculator system), users may be able to interact transparently with the deep structure at the outset, so learning activities will not be needed and, if undertaken, would offer few benefits. However, for complex systems, users typically have to engage in substantial learning activities to use the IS transparently (as Boudreau and Robey 2005 showed with ERP usage).

Explaining Task Performance

The theoretical model in Figure 1 suggests that certain 'states' of the user and system trigger the user to engage in certain 'actions' that influence his/her 'state' of effective system usage that, in turn, influences his/her 'state' of task performance. Note that we do not specify any intermediate 'actions' between the state of effective usage and the state of task performance. This is because it is difficult to identify any actions that would be common to all ISs and all tasks. For instance, if we consider the example (above) of the researcher using statistical software, if the task in focus is the statistical analysis alone, then effective usage of the software should have a direct effect on this outcome (without the need for any intermediate constructs). However, if the task in focus is the entire piece of research, then it would be useful to include intermediate actions such as whether the researcher acted upon the statistical result he obtained from the system to improve the research (e.g., collecting new data). In task-specific models of effective usage, the task is known, so researchers can specify precisely how effective usage should affect performance, e.g., directly (Pavlou et al. 2008) or via specific mediators (Ahearne et al. 2008). Because our model is general rather than task-specific, it is not possible for us to specify a mediating chain of constructs. Thus, we simply pose a direct link between our two components of effective usage and task performance and we limit the task in focus to the task for which the system is being used. In this context, we offer Proposition 7:

Proposition 7: *Effective system usage will positively affect users' task performance. This will be seen in a positive effect of fit-in-use on performance (**P7a**) and a positive effect of transparent interaction on performance (**P7b**).*

In Proposition 7, task performance refers to an assessment of task output in terms of its effectiveness (Sonnentag and Frese 2002). Fit-in-use should have a positive effect on task performance because if a person uses their IS in a manner that fits the task, then the required tasks outputs should be more likely to eventuate than if the IS is used in a way that does not fit the task (**P7a**). This proposition is consistent with findings in past research that a given IS can have positive or negative effects on performance, depending on how well people use it (Marcolin et al 2000). For example, although knowledge management systems (KMS) are designed to assist knowledge workers, Haas and Hansen (2005) found that consultants in one firm used their KMS in a way that did not fit their tasks (simply mining it for past proposals), which led to low task performance, whereas Ahearne et al. (2008) found that consultants in a different firm used their KMS in a way that fit their tasks (selecting pieces of knowledge that would be relevant when meeting clients), which increased their task performance.

Transparent interaction should also have a positive effect on task performance because if a person is more able to interact with the representations in the IS, s/he should be more able to reap whatever benefits can be attained from the representations (**P7b**). For example, consider an accountant using a package such as QuickBooks. The accountant is unlikely to be able to perform her task effectively if she has difficulty finding relevant functions in the menu structure (surface structure) and if the computer she is using is slow and prone to crash (physical structure). In contrast, if the surface structure and physical structure cause her no problem, she is more likely to perform effectively because she is less likely to be distracted and can focus her attention on her task—a key driver of performance (Ashcraft 2002, Eysenck 1982).

Scope Limitations

Our model aims to fill a gap in the literature by helping to identify and explain the nature and drivers of effective system usage for information systems in general. However, it has four key limitations. First, it only explains effective usage in the context of a single user interacting with a single IS. It does not consider issues that arise when multiple users interact with an IS (i.e., collective usage), when users interact with systems through intermediaries (i.e., indirect usage), or when users interact with systems on multiple tasks (i.e., multitasking). We discuss briefly later how the model might be extended to account for some of these issues, but a full discussion lies outside the scope of our work (see Burton-Jones and Gallivan 2007, Kane and Alavi 2008).

Second, our model is designed to apply to any IS. Because of its generality, it would be unlikely to explain effective system usage for any given system as well as a model designed for that specific system. Long ago, Weick (1979) pointed out that researchers must make a trade-off because no theory can be at once simple, accurate, and generalizable. In this light, it would be ideal if researchers had *both* general and task- or IS-specific models of effective usage.

Third, we have not included any control variables in the model. We recognize that many variables could influence each construct but have tried to limit the model to only those constructs that we felt could be deduced directly or indirectly from representation theory. For example, if a researcher was testing the model via a survey, s/he would need to control for other factors that could influence both effective system usage and task performance (such as the users' intelligence, motivation, or knowledge of the task) for the study to have internal validity.

Finally, the model specifies time lags for each proposition to enable researchers to test for causality, but it does not specify the length of time required for each lag. At this stage, we do not have enough theory to do so. Ultimately, this will require empirical tests (and theory development informed by these tests) to determine.

Despite these limitations, we believe the model makes a contribution by filling a gap in the academic literature and addressing an important issue in real world organizations. In the next section, we set out to provide indicative evidence that the theory might be useful by illustrating how it could help explain the effective use of several types of systems in practice.

EXAMPLES

Representation theory states that *all* information systems provide representations. Although it is not feasible to illustrate how our model can apply to all information systems, one way to approach this ideal is to give examples of major *types* of information system. This is the approach we take. To do so, we drew on Borgmann's (1999) treatise on types of information. Borgmann suggests that there are just three types of information: information *about* reality, which tells us about states in the world (e.g., reports and records), information *for* reality, which helps us take actions in the world (e.g. plans and recipes), and information *as* reality, which presents itself to us directly, as if it were reality (e.g., music recordings and teleconferences). Following this typology, we provide examples of how our model can be used to explain the effective use of three types of systems: reporting systems, planning systems, and recording systems. At first glance, Wand and Weber's representation theory seems most suited to studying reporting systems (which provide information about reality). However, as we will show, we believe that our model can explain the effective use of all three types of systems.

Reporting Systems: Systems providing information *about* reality

In prior sections, we provided brief examples of several systems that give reports about some segment of reality, e.g., sales systems, inventory systems, and accounting systems. A common attribute of these systems was that they are database-driven. To complement these examples, Table 3 gives an example of a non-database reporting system: a word processor used to write a report. As Table 3 shows, our model can be used to explain effective usage in this case as well.

Table 3: Example – Word Processing	
Proposition	**Example**
1, a and b *Drivers of reality verification*	When writing a research report, a researcher is creating deep structure (text/data) as she writes. Intermittently, the researcher will likely assess the fidelity of what she has written (i.e., whether it reflects her thinking completely, clearly, meaningfully, and correctly). If it is deficient, she will likely engage in reality verification (e.g., by checking her arguments, her statistical output, or checking arguments in prior papers). As representational fidelity improves (e.g., when the report is in final drafts), it is likely that fewer acts of reality verification will be undertaken.
2, a and b *Drivers of system adaptation*	If a researcher notices that her report lacks fidelity, she will likely engage in adaptation. The most likely adaptation is to deep structure (e.g., she will change what she has written). However, she may also adapt other structures. For example, she may add shortcuts to the toolbar to allow her to edit the report faster. Likewise, she may notice that a table in the report is corrupt and run a file recovery tool to restore it or she may connect her computer to a larger monitor to help her view the report more clearly. In different situations, a researcher may have more ability to engage in these adaptations. If she is more constrained, she will make fewer adaptations.
3, a and b *Drivers of system learning*	The more complex the structures of the system, the more the researcher will need to learn them. For example, if the word processor has a complex interface (surface structure) with many irrelevant functions, she will have to spend time learning which functions are relevant and how to access them. Likewise, if the report she is writing (deep structure) is complex, she is likely to spend time reading what she has written to understand her arguments (for as Weick 1995, p. 12 noted, writers often have to reflect on what they are writing to learn what they are thinking). Finally, if her references are stored and managed online (e.g., via RefWorks), she may have to learn how to obtain the necessary connectivity (physical structure). Of course, the researcher will need resources and time to engage in such learning activities.

Table 3: Example – Word Processing	
4, a, b, and c *Antecedents to fit-in-use*	It seems clear that the more the researcher adapts the deep structure (e.g., the text and data of her report), the more likely she will reach a state in which her interactions with it fit her task requirements (i.e., the more likely she will be writing the type of report she needs to write). However, such adaptations are more likely to benefit fit-in-use if the report has deficiencies and if she has taken steps to check its veracity.
5 *Impact of system adaptation on transparent interaction*	The researcher is likely to interact more transparently with the deep structure (i.e., what she is writing) if she has taken steps to adapt the surface and physical structure of her system to facilitate her access to it. For example, if the package she is using offers a default way of 'viewing' her report (e.g., the "reading" view in MS Word), she might find that by changing the view (e.g., to a "print layout" view in MS Word), she can see more clearly how her report is developing. Likewise, by choosing a larger physical monitor, she might be able to view her arguments more clearly.
6, a and b *Impact of system learning and system complexity on transparent interaction*	The more the user learns the structures of the system, the more likely she will be able to interact transparently with her report as she writes it. This will especially be true for systems that have complex structures. For example, the system's interface may be more complex when she is viewing the report in a 'reviewing' mode (i.e., when she is checking changes made to prior versions by different coauthors). In this case, if the researcher has taken actions to learn how the reviewing function works, she will be more likely to interact with the report seamlessly in the reviewing mode rather than being distracted or anxious due to her lack of understanding of how this mode works.
7, a and b *Effect on task performance*	The more the researcher is writing a report that fits her task requirements and the more she is interacting with the word processing system in an efficient manner, the more likely she will write a good report, i.e., achieve higher task performance.

Planning Systems: Systems providing information *for* reality

Planning systems provide information that people use to take actions. Materials Requirements Planning (MRP) systems are a good example. MRP systems help companies decide which items and how many to purchase and produce to meet customer demands, while minimizing the costs of production, distribution, and storage. MRP systems can be stand-alone or integrated with other systems such as ERP systems. In Table 4, we show that our model can be used to explain the effective use of such systems. The only major difference between our example in

Table 4 and the example of the reporting system in Table 3 is that in the case of the planning system, some of the effects of effective usage on performance do not occur immediately, but instead only occur some time after the plan (which the system provides) is executed.

Table 4: Example – Materials Requirements Planning	
Proposition	**Example**
1, a and b *Drivers of reality verification*	An MRP system needs input data to create a plan, e.g., customers' demand (e.g., past purchases and expected purchases), manufacturing times for items, item shelf-life, inventory on hand, inventory on order, and so forth. If the user is concerned that the inputs used to determine the plan are deficient, he will likely engage in actions to verify them to ensure that the system uses correct data. For example, if he has the resources, contacts, and time to do so, he may verify inventory or sales data by examining the numbers in other corporate systems or, if they also lack integrity, via discussions with experts in the inventory or sales divisions who have tacit knowledge.
2, a and b *Drivers of system adaptation*	In addition to input data being deficient, the planning algorithms might also be deficient, e.g., they may have been implemented in a vanilla fashion rather than being tailored to the supply chain context of the company. If the user is aware of such deficiencies, he will likely engage in actions to adapt the algorithms. If the system offers the user the ability to change the algorithm directly, the user may do so (e.g., via configuration settings). Alternatively, the user may submit a change request to IT staff to change the algorithm. However, if the user is constrained in terms of time and resources, he may be unable to make the adaptations needed.
3, a and b *Drivers of system learning*	An MRP system is complex because it involves the consideration of many parameters that fluctuate over time (deep structure), produces complex output such as production and purchasing schedules that must be presented in an understandable manner (surface structure), and can be computationally intensive and require connectivity with other systems for inputs (physical structure). As a result, the user is likely to engage in learning activities if he has the ability to do so. For example, he is likely attend training classes, read systems documentation, discuss the system with other MRP users, or if these are unavailable, at least explore it or experiment with it.
4, a, b, and c *Antecedents to fit-in-use*	If the inputs or algorithms in the MRP system are deficient, adapting them, or the way they are used, will improve the extent to which the system supports the planning task. Adaptations are more likely to improve fit-in-use if the user has carefully verified which input data and algorithms are deficient and if he has verified his own understanding of how they should appear in the system.

Table 4: Example – Materials Requirements Planning	
5 *Impact of system adaptation on transparent interaction*	The user is likely to benefit from making adaptations to the surface and physical structure of the system to improve the extent to which he can interact with it transparently. For example, he may adapt the interface to make it easier to access functions that he often uses and he may change the way the output (such as the production schedule) is presented to make it easier to interpret. Finally, he may adapt the machine on which the system runs to make it run faster and more reliably. All of these changes should allow him to interact with the deep structure of the system (i.e., its data, functions, and the meaning of its output) in a more efficient manner.
6, a and b *Impact of system learning and system complexity on transparent interaction*	Because MRP systems are complex systems, the user is likely to interact with the system more transparently if he engages in learning activities. For example, he might have a hard time using the MRP system's interface, choosing which planning features to use, or interpreting the system's output, so he may attend a training course to improve his understanding. The more complex the MRP system (e.g., the more functionality it has, the more detailed the output, and the more dependent it is on other related systems), the more vital and helpful these learning activities will become.
7, a and b *Effect on task performance*	When the MRP system is used in a manner that fits the task, the plans produced by the system are likely to be of higher quality. Likewise, when the user interacts with the system more transparently, the user is likely to get his work done more quickly. Although both of these outcomes occur immediately, the after-effects of these outcomes will take longer to materialize because it depends on the results of the implemented plan. For example, if the system produces a poor plan, the company may overstock certain items, but the company might not realize this until three months later when overstocked items have past their shelf life and need to be discarded.

Recording Systems: Systems providing information *as* reality

According to Borgmann (1999), recording systems provide information as reality. Consider a Bach cantata on CD. Although the music is just a recording of what happened in a particular recording studio, Borgmann (1999) argues that most listeners do not think of it in this way; rather, they experience the music *as* reality, i.e., as music that they hear and enjoy (or not). In Table 5, we show that our model is able to explain the effective use of a recording system—a video conferencing system. The only major difference between the example in Table 5 and the prior examples is that in the case of *real-time* recording systems, users sometimes have the option to adapt the real world being recorded or to adapt the representation provided by the system. For example, if a user cannot hear participants clearly in a conference call, he could increase the volume on his receiver or ask participants to talk louder – either action might achieve the same end. With reporting and planning systems, the distinction between adapting the representation and adapting the world is usually more distinct and consequential. For example, when a researcher changes her report, it may reflect a change in her thinking, but changing her thinking and changing the report do not achieve the same end, rather both are required. Likewise, when a planner changes an algorithm in her MRP system, this may change the plan of what to do in the world, but changing the plan and changing the world (implementing the plan) achieve different ends. Despite this difference between recording systems and the other systems, our model readily explains the effective use of all three types of system.

Table 5: Example – Video Conferencing

Proposition	**Example**
1, a and b *Drivers of reality verification*	If there is no problem with the fidelity of the conference (e.g., its completeness and clarity), few efforts to engage in reality verification will likely be undertaken. However, if problems occur, reality verification may well be undertaken if conference participants are able to do so. For example, if the conference is incomplete (i.e., a key person is missing), members may phone the person to determine the reason why she is not in the conference (e.g., is she unable to connect, is she connected but her image/voice cannot be seen/heard, or has she not even attempted to connect?).
2, a and b *Drivers of system adaptation*	If there is no problem with the fidelity of the conference (e.g., its completeness and clarity), adaptations are unlikely. However, such efforts are likely if problems occur. For example, users may change the deep structure of the system (e.g., changing a setting so that it supports presentation slides, not just audio and video), the surface structure (e.g., resizing the display window to show the video in a larger size) and the physical structure (e.g., changing network settings to increase reliability or moving the recording device to show the image more clearly). Sometimes, users may have the option to adapt the system or the real world directly – either may achieve the same purpose, e.g., to make the conference call clearer, users may adjust the volume on their receivers or simply ask some participants to talk louder or more clearly.
3, a and b *Drivers of system learning*	Videoconference systems can range in complexity from simple desktop systems for one-on-one conversations over the Internet to large corporate systems that enable multi-party conversations and provide audio, visual, and data transmission through

Table 5: Example – Video Conferencing	
	proprietary encrypted networks. The more complex the system, the more likely that users will engage in acts to learn how it works (e.g., learning how to add and drop participants, how to avoid echo feedback, how to ensure reliable transmission, etc).
4, a, b, and c *Antecedents to fit-in-use*	If there is no deficiency in the video conference, adaptations are unlikely to improve the extent to which the video conference is meeting its purpose. However, if there is a problem in the call (e.g., a participant has not signed on, cannot be seen, or has dropped out), changes may need to be made and acts of reality verification may be needed. For example, the missing person may need to be contacted to determine the problem and that person may need to be added back into the call or a substitute may need to be added to ensure that the conference call can achieve its purpose.
5 *Impact of system adaptation on transparent interaction*	Changes to the surface and physical structure of the video conference will often help attendees to see and hear others and participate themselves. For example, participants may resize their display window to see each other more clearly, adapt the computer or network settings to increase reliability, and adjust their microphone so that it picks up their voice while not picking up echo interference. These changes should help reduce distractions and enable attendees to participate more easily.
6, a and b *Impact of system learning and system complexity on transparent interaction*	If the conference call system is simple, it is unlikely that learning activities will help participants to engage more fully in the call. However, if the system is complex, such learning activities may help. For example, if the conference call involves data transmission (e.g., showing presentation slides and sharing data files), participants will be able to engage in the call more fully if they know how these features work (e.g., if they know how to show presentation slides during the call and how to open, edit, save, and share files quickly during the call). If they don't know these features, they will have to learn them during the call, distracting them from the ongoing conversation.
7, a and b *Effect on task performance*	If the videoconference system is used in a way that fits the task, and if participants are fully engaged in the call, participants' use of the system will be more likely to improve their performance in the task in which it is being used (compared to a case in which the system is not used in a way that fits the task and/or in which participants are distracted by the system and therefore unable to engage fully in the conference).

Summary of Examples

These examples suggest that researchers can use our model to study the effective usage of a wide range of systems. We recognize that researchers would need ways to operationalize the model and that it is limited in scope and could be extended. We discuss these issues next.

DISCUSSION

We discuss four issues in turn: how the model could be operationalized and tested, how it could be extended, its contributions to research, and its implications for practice.

Operationalizing and testing the model

The model is in a formative stage, having not yet been operationalized and tested. Several issues would have to be considered when doing so. One key issue is that all the constructs are defined 'objectively' rather than subjectively (i.e., in terms of perceptions). Because all data is at least somewhat subjective, researchers testing the model would ideally collect data from multiple sources and triangulate on the true scores of each construct.

A second important issue is that several of the constructs have multiple dimensions. For example, adaptations can involve adapting the *system* or the way it is *used*, adapting the *deep*, *surface*, and/or *physical* structure, and adapting the IS *directly* or *indirectly* (per Table 2). As a result, researchers could measure the constructs in two general ways. One would be to use reflective measures to capture the entire construct. For example, a researcher might ask a user "to what extent have you adapted the system?" Alternatively, researchers could develop measures for each dimension of the construct and use these to compute (form) measures of the overall construct. In the early stages of testing the model, both strategies would likely be useful.

Finally, the model must be tested longitudinally. There are clear time lags between each stage of the model. Because our theory is not sufficiently detailed to specify the precise time required for each lag, researchers would ideally test it with different periods to obtain insight into the times required. Moreover, the three actions that drive effective use (reality verification, adaptation, and learning) are all acts of agency. Depending on the situation, acts of agency can occur frequently or infrequently (Majchrzak et al. 2000, p. 594). Thus, longitudinal research would be needed to ensure that researchers could identify these acts when they occur.

Extending the model

Although the model could be extended in several ways, we believe that two extensions would be especially valuable. First, it would be useful to extend the model so that it includes process theory (Markus and Robey 1988). A central limitation with the current model is that it does not incorporate cycles of feedback. In their study of user adaptation, Beaudry and Pinsonneault (2005) proposed a process theory that included four stages (awareness of event → appraisal → adaptation strategy → outcome). It also included a feedback loop from the 'outcome' back to the 'appraisal,' thereby enabling researchers to understand the process by which users adapt their systems over time. In a similar way, our model could be extended to: (a) include users' awareness of events associated with each of our antecedents (i.e., events that change a system's representational fidelity, its complexity, or the users' ability to verify, adapt, or learn it), and (b) include a feedback loop from task performance back to users' awareness of events and to their actions (e.g., actions to verify, adapt, and learn the system). It is likely that the addition of these process components to the variance model would help researchers obtain a more detailed understanding of how effective use emerges and evolves.

A second useful way to extend the model would be to expand its scope to include contexts in which: (a) individuals use an IS as part of a coordinated group of people, and/or (b) users need to employ multiple systems in a coordinated fashion for their tasks. To extend our model in this way, we believe researchers would benefit from using distributed cognition (DCog) theory (Hutchins 1995). DCog theory is consistent with representation theory because it focuses on how individuals create and use representations to facilitate work. It is also particularly useful for studying collectives and networks because it pays attention to the way that people coordinate their use of representations across different media, different people, and different time periods. Extending the model in this way might contribute significantly to recent multilevel and social networks studies of system usage (Burton-Jones and Gallivan 2007, Kane and Alavi 2008).

Contributions to research

Although the proposed model is in a formative stage and has a limited scope, we believe that it contributes to research in two main ways. The main contribution is that it provides the first model to our knowledge of the nature and drivers of effective system usage for information systems in general (rather than a specific type of system). By doing so, our model fills a gap in the literature and complements research on the nature and drivers of effective usage for specific types of systems such as collaboration systems (Pavlou et al. 2008) and ERP systems (Boudreau and Seligman 2005).

The second contribution is that it extends Wand and Weber's (1990, 1995) representation theory. Although proposed almost two decades ago, representation theory has been used almost solely to date in one small sub-domain of IS research: conceptual modeling (see Weber 1997). Recently, researchers have extended the theory to study a wider range of domains, such as IS maintenance (Heales 2002) and IS alignment (Rosemann et al. 2004, Sia and Soh 2007). Our paper adds to this stream of research. Given that the theory has now been applied to a range of domains, it would appear fruitful to see whether the theory could prove useful in additional domains of IS research. Likewise, it would be interesting to see whether other general theories of information systems could be used to study effective usage. Researchers could then develop competing models based on these different general theories.

Implications for practice

As a theoretical paper, our paper can offer only modest contributions to practice. Nevertheless, we believe that the model could ultimately prove useful for practitioners because: (a) effective usage is a very important phenomenon in practice, (b) the model is applicable to many types of systems in practice, and (c) the model proposes a relatively parsimonious set of factors to explain effective usage. We believe the model would be particularly useful for supporting evidence based management (Pfeffer and Sutton 2006). The notion of evidence-based management is that managers must have good data to support their decision making. The long literature on IT productivity has shown that many firms struggle to get performance improvements from their information systems. In this light, managers should benefit from having metrics on how effectively employees are actually *using* their information systems. Like Deveraj and Kohli (2003), we believe that this is the key driver of IT impacts in practice. Thus, we suggest that managers could institute a metrics program based on our model and use these metrics to determine: (a) how effectively employees are using their systems, and (b) the extent to which effective usage can be increased via initiatives that focus on improving its drivers (e.g., minimizing or removing representational deficiencies, simplifying systems where possible, and improving users' ability to verify, adapt, and learn their systems). We believe such a program could help managers to improve the returns on their investments in information systems.

CONCLUSION

This paper proposed a model of the nature and drivers of effective system usage. To complement research on the effective use of specific types of information systems, we drew on a theory known as 'representation theory' to propose a model that is designed to explain the effective usage of any information system. Despite acknowledged limitations, we believe that the proposed model contributes to research by adding to our understanding of how information systems can affect users' task performance and contributes to practice by providing insights to managers about how to leverage their IT investments and track their success in doing so. The model offers many opportunities for extension and refinement. Given the massive reliance on information systems in business and society, we believe these opportunities offer great potential for further contributions to research and practice.

REFERENCES

Ahearne, M., Jones, E., Rapp, A. and Mathieu, J. "High Touch Through High Tech: The Impact of Salesperson Technology Usage on Sales Performance via Mediating Mechanisms," *Management Science* (54:4) 2008, pp. 671-685.

Ahuja, M.K., and Thatcher, J.B. "Moving Beyond Intentions and Toward the Theory of Trying: Effects of Work environment and Gender on Post-adoption Information Technology Use," *MIS Quarterly* (29:3), 2005, pp. 427-459.

Ashcraft, M.H. *Cognition*, (3rd ed.) Prentice Hall, Upper Saddle River, New Jersey, 2002.

Barki, H., Titah, R., and Boffo, C. "Information System Use-Related Activity: An Expanded Behavioral Conceptualization of Information System Use," *Information Systems Research* (18:2) 2007, pp. 173-192.

Benbasat, I, and Barki, H. "Quo Vadis TAM," *Journal of the Association for Information Systems* (8:4) 2007 pp. 211-218.

Benbasat, I., and Zmud, R.W. "The Identity Crisis Within the IS Discipline: Defining and Communicating the Discipline's Core Properties," *MIS Quarterly* (27:2) 2003, pp 183-194.

Bodker, S. "Understanding Representation in Design," *Human-Computer Interaction* (13) 1998, pp. 107-125.

Borgmann, A. *Holding on to Reality: The Nature of Information at the Turn of the Millennium*, University of Chicago Press, Chicago USA 1999.

Boudreau, M.-C., and Robey, D. "Enacting Integrated Information Technology: A Human Agency Perspective," *Organization Science* (16:1), 2005, pp 3-18.

Boudreau, M-C., and Seligman, L. "Quality of Use of a Complex Technology: A Learning-Based Model," *Journal of Organizational and End User Computing* (17:4) 2005, pp. 1-22.

Brooks, F.P. *The Mythical Man-Month*, 20th Anniversary Edition, Addison Wesley, MA, 1995

Burton-Jones, A. and Gallivan, M.J. "Towards a Deeper Understanding of System Usage in Organizations: A Multilevel Perspective," *MIS Quarterly* (31:4) 2007, pp. 657-679.

Burton-Jones, A. and Straub, D.W. "Reconceptualizing System Usage: An Approach and Empirical Test," *Information Systems Research* (17:3) 2006, pp. 228-246.

Butler, B. S. and Gray, P.H. "Reliability, Mindfulness, and Information Systems," *MIS Quarterly* (30:2) 2006, pp. 211-224.

Chin, W.W., Gopal, A., and Salisbury, W.D. "Advancing the Theory of Adaptive Structuration: The Development of a Scale to Measure Faithfulness of Appropriation," *Information Systems Research* (8:4) 1997, pp 342-367.

Davis, R., Shrobe, H. and Szlovits, P. "What is a Knowledge Representation?" *AI Magazine* (Spring) 1993, pp. 17-33.

Davern, M.J. "When Good Fit is Bad: The Dynamics of Perceived Fit," in *Proceedings of the 17th International Conference on Information Systems*, Cleveland, Ohio, 1996, pp. 112-121.

Dennis, A.R., Wixom, B.H., and Vandenberg, R.J. "Understanding Fit and Appropriation Effects in Group Support Systems via Meta-Analysis," *MIS Quarterly* (25:2), 2001, pp 167-193.

DeSanctis, G., and Poole, M.S. "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory," *Organization Science* (5:2) 1994, pp 121-147.

Devaraj, S., and Kohli, R. "Performance Impacts of Information Technology: Is Actual Usage the Missing Link?" *Management Science* (49:3) 2003, pp 273-289.

Eysenck, M.W. *Attention and Arousal: Cognition and Performance* Springer-Verlag, Berlin, 1982.

Galletta, D.F., Henry, R.M., McCoy, S., and Polak, P. "When the Wait Isn't So Bad: The Interacting Effects of Web Site Delay, Familiarity, and Breadth," *Information Systems Research* (17:1) 2006, pp. 20-37.

Gallivan, M.J., Spitler, V.K., and Koufaris, M. "Does Information Technology Training Really Matter? A Social Information Processing Analysis of Coworkers' Influence on IT Usage in the Workplace," *Journal of Management Information Systems* (22:1) 2005, pp 153-192.

Goodhue, D.L., and Thompson, R.L. "Task-Technology Fit and Individual Performance," *MIS Quarterly* (19:2) 1995, pp 213-236.

Griffith, T.L. "Technology Features as Triggers for Sensemaking," Academy of Management Review (24:3) 1999, pp 472-488.

Haas, M.R. and Hansen, M.T. "When Using Knowledge Can Hurt Performance: The Value of Organizational Capabilities in a Management Consulting Company," *Strategic Management Journal* (26) 2005, pp. 1-24.

Heales, J. "A Model of Factors Affecting an Information System's Change in State," *Journal of Software Maintenance* (14:6) 2002, pp. 409-427.

Hovorka, D.S., Germonprez, M. and Larsen K.R. "Explanation in Information Systems," *Information Systems Journal* (18:1) 2008, pp. 23–43.

Hutchins, E. *Cognition in the Wild*, MIT Press, Bradford, 1995.

Jasperson, J., Carter, P.E., and Zmud, R.W. "A Comprehensive Conceptualization of the Post-Adoptive Behaviors Associated with IT-Enabled Work Systems," *MIS Quarterly* (29:3) 2005, pp. 525-557.

Johnson, R.D., Marakas, G.M. "The Role of Behavioral Modeling in Computer Skills Acquisition: Toward Refinement of the Model," *Information Systems Research* (11:4) 2000, pp. 402-417.

Kane, G.C. and Alavi, M. "Casting the Net: A Multimodal Network Perspective on User-System

Interactions,” *Information Systems Research*, forthcoming, 2008.
Kent, W. *Data and Reality*, 1st Books Library, 2000 (originally published 1978).
Lave, J., and Wenger, E. *Situated Learning: Legitimate Peripheral Participation* Cambridge University Press, UK, 1991.
Lee, A.S. "Integrating Positivist and Interpretive Approaches to Organizational Research," *Organization Science* (2) 1991, pp 342-365.
Leonardi, P.M. “Activating the Informational Capabilities of Information Technology for Organizational Change,” *Organization Science* (18:5) 2007, pp. 813-831.
Majchrzak, A., Rice, R.E., Malhorta, A., King, N., and Ba, S. "Technology Adaptation: The Case of a Computer-Supported Inter-Organizational Virtual Team," *MIS Quarterly* (24:4) 2000, pp 569-600.
March, J.G. "Exploration and Exploitation in Organizational Learning," *Organizational Science* (2:1) 1991, pp 71-87.
Marcolin, B.L., Compeau, D., Munro, M.C., and Huff, S.L. "Assessing User Competence: Conceptualization and Measurement," *Information Systems Research* (11:1) 2001, pp 37-60.
Markus, M.L., and Robey, D. "Information Technology and Organizational Change: Causal Structure in Theory and Research," *Management Science* (34:5) 1988, pp 583-598.
Mathieson, K., Peacock, E., and Chin, W.W. "Extending the Technology Acceptance Model: The Influence of Perceived User Resources," *The DATA BASE for Advances in Information Systems* (32:3) 2001, pp 86-112.
Meeker, M., Joseph, D., and Ji, R. "Technology/Internet Trends,” Presentation by Morgan Stanley Research at the *Web 2.0 Summit*, San Francisco, October 18, 2007.
Meister, D.B., and Compeau, D.R. "Infusion of Innovation Adoption: An Individual Perspective," in *Proceedings of the Annual Conference of the Administrative Sciences Association of Canada* (ASAC), May 25-28, Winnipeg, 2002, pp. 23-33.
Nambisan, S., Agarwal, R., and Tanniru, M. "Organizational Mechanisms for Enhancing User Innovation in Information Technology," *MIS Quarterly* (23:3), 1999, pp. 365-395.
Orlikowski, W.J. "Integrated Information Environment or Matrix of Control? The Contradictory Implications of Information Technology," *Accounting, Management and Information Technologies* (1:1) 1991, pp 9-42.
Orlikowski, W.J. "Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations," *Organization Science* (11:4) 2000, pp 404-428.
Orlikowski, W.J., and Baroudi, J.J. "Studying Information Technology in Organizations: Research Approaches and Assumptions," *Information Systems Research* (2) 1991, pp 1-28.
Orlikowski, W.J., and Iacono, C.S. "Research Commentary: Desperately Seeking the "IT" in IT

Research - A Call to Theorizing the IT Artifact," *Information Systems Research* (12:2), 2001, pp 121-134.

Overby, E. "Process Virtualization Theory and the Impact of Information Technology," *Organization Science* (forthcoming) 2008, pp. 1-14.

Pavlou, P.A. and El-Sawy, O.O. “From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development,” *Information Systems Research* (17:3) 2006, pp. 198-227.

Pavlou, P., Dimoka, A., and Housel, T.J. “Effective Use of Collaborative IT Tools: Nature, Antecedents, and Consequences,” *Proceedings of the 41st Hawaii International Conference of System Sciences* (HICSS), Hawaii, Jan 7-10, 2008.

Pfeffer, J. and Sutton, R.I. "Evidence-Based Management," *Harvard Business Review*, Jan. 2006, pp. 62-74.

Robey, D., Schwaig, K.S., and Jin, L. “Intertwining Material and Virtual Work,” *Information and Organization* (13:2) 2003, pp. 111-129.

Rosemann, M., Vessey, I., and Weber, R. “Alignment in Enterprise Systems Implementations: The Role of Ontological Distance,” *Proceedings of the 25th International Conference on Information Systems*, Washington, D.C., USA, 2004, Dec 12-15, 2004, pp. 11-19.

Ruhleder, K. “Rich and Lean Representations of Information for Knowledge Work: The Role of Computing Packages in the Work of Classical Scholars,” *ACM Transactions on Information Systems* (12:2) 1994, pp. 208-230.

Sia, S.K. and Soh, C. “An Assessment of Package-Organisation Misalignment: Institutional and Ontological Structures,” *European Journal of Information Systems* (16:5) 2007, pp. 568-583.

Sesé, F.; Wareham, J.; Bonet, E. "Words and Objects in Information Systems Development: Six Paradigms of Information as Representation," *Proceedings of the 14th European Conference on Information Systems*, Göteborg, Sweden, 2006.

Simmons, T. and Manahan, M. "The Effects of Monitor Size on User Performance and Preference," in *Proceedings of the Human Factors and Ergonomics Society 43rd Annual Meeting* 1999, p. 1393.

Sonnentag, S., & Frese, M. "Performance Concepts and Performance Theory," in: *Psychological Management of Individual Performance*, S. Sonnentag (ed.), Wiley, UK, 2002, pp. 3-25.

Spitler, V. K. “Learning to Use IT in the Workplace: Mechanisms and Masters,” *Journal of Organizational and End User Computing* (17:2), 2005, pp. 1-26.

Stamper, R., Liu, K., Hafkamp, M., and Ades, Y. "Understanding the Roles of Signs and Norms in Organizations - A Semiotic Approach to Information Systems Design," *Behaviour & Information Technology* (19:1), 2000, pp. 15-27.

Subramani, M. "How do Suppliers Benefit from Information Technology Use in Supply Chain Relationships," *MIS Quarterly* (28:1), 2004, pp 45-74.

Suchman, L. “Making Work Visible,” *Communications of the ACM* (38:9) 1995, pp. 56-64.

Swanson, E.B., and Ramiller, N.C. "Innovating Mindfully with Information Technology," *MIS Quarterly* (28:4) 2004, pp 553-584.

Vaast, E. and Walsham, G. “Representations and Actions: The Transformation of Work Practices with IT Use,” *Information and Organization* (15:1) 2005, pp. 65-89.

Venkatesh, V., Morris, M.G., Davis, G.B., and Davis, F.D. "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27:3), 2003, pp. 425-478.

Vessey, I. "Cognitive Fit: A Theory-Based Analysis of the Graphs versus Tables Literature," *Decision Sciences* (22:2) 1991, pp. 219-240.

Walsham, G. “Knowledge Management Systems: Representation and Communication in Context,” *Systems, Signs & Actions* (1:1) 2005, pp. 6-18.

Wand, Y. and Wang, R.Y. “Anchoring Data Quality in Ontological Foundations,” *Communications of the ACM* (39:11) 1996, pp. 86-95.

Wand, Y., and Weber, R. "An Ontological Model of an Information System," *IEEE Transactions on Software Engineering* (16:11), 1990, pp. 1282-1292.

Wand, Y., and Weber, R. "On the Deep Structure of Information Systems," *Information Systems Journal* (5:3) 1995, pp. 203-223.

Weber, R. *Ontological Foundations of Information Systems*, Coopers & Lybrand and Accounting Association of Australia and New Zealand, Melbourne, 1997.

Weber, R. "Editor's Comments: Still Desperately Seeking the IT Artifact," *MIS Quarterly* (27:2), 2004, pp. iii-xi.

Weick, K.E. *The Social Psychology of Organizing*, Addison-Wesley, Reading MA, 1979.

Weick, K.E. *Sensemaking in Organizations*, Sage Publications, Thousand Oaks, CA, 1995.

Wixom, B.H, and Todd, P.A. “A Theoretical Integration of User Satisfaction and Technology Acceptance,” *Information Systems Research* (16:1) 2005, pp. 85-102.

Wood, R.E. "Task Complexity: Definition of the Construct," *Organizational Behavior and Human Decision Processes* (37:1) 1986, pp. 60-82.

Yoo, Y., Boland, R.J., and Lyytinen, K. “From Organization Design to Organization Designing,” *Organization Science* (17:2) 2006, pp. 215-229.

Yourdon, E. *Modern Structured Analysis*, Prentice Hall, Englewood Cliffs, NJ. 1989.

芽|Sprouts
Working Papers on Information Systems | ISSN 1535-6078

Office:
Sprouts
University of Amsterdam
Roetersstraat 11, Room E 2.74
1018 WB Amsterdam, Netherlands
Email: admin@sprouts.aisnet.org