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A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole's Concepts of Structural Features and Spirit *

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Abstract

Gerardine DeSanctis and Marshall Scott Poole made an important contribution to the study of IT uses and effects with their insightful concepts of "structural features" and "spirit." Unlike their concept of "appropriation," which has found broad acceptance in the IS community, the concepts of structural features and spirit have not been widely used. Published concerns that the concepts are not consistent with basic assumptions in Giddens' structuration theory, on which the concepts were based, could account for their neglect. However, concepts like structural features and spirit are indispensable for any program of research that attempts to show how IT artifacts can, together with other influences, contribute to the consequences of IT use. Addressing the criticisms that have been leveled against these concepts is, therefore, important. In this paper we unpack DeSanctis and Poole's concepts and propose redefining them as three new concepts: technical objects, functional affordances, and symbolic expressions. We believe this reconceptualization addresses several concerns about the original concepts, while retaining the core insights of DeSanctis and Poole's innovative analysis.

Keywords: *Conceptualization of the IT artifact, IT effects research, IS design science, Adaptive Structuration Theory, structural features, spirit, causality, materiality of IT, IT and values, affordances, boundary object, diffusion of innovations theory, ecological psychology, semiotic engineering, technical objects, symbolic expressions*

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* Marshall Scott Poole and Jonathon Cummings were the accepting guest editors.

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A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole's Concepts of Structural Features and Spirit

1. Introduction

When Gerardine DeSanctis and her colleagues at the University of Minnesota undertook a program of design-oriented research on group decision support systems (GDSS) in the 1980s, their goal was to understand the effects of IT on group behavior, such as altered member participation and improved decision quality (DeSanctis and Gallupe, 1987). In the course of their research, Gerry and her colleagues found inconsistent results from one study to the next and concluded that the effects of technology on human behavior are contingent on social practices. Accordingly, Gerry and her collaborator Marshall Scott Poole saw the need for a new theoretical framework that would avoid the problems associated with a deterministic view of IT outcomes while still facilitating the study of IT effects. The result was Adaptive Structuration Theory (AST), now viewed as a seminal contribution to the IS field (DeSanctis and Poole, 1994).

By pairing two innovative technology-oriented concepts, *structural features* and *system spirit,* AST made an important contribution to the conceptualization of what it is *about IT* that may contribute to the behavioral and social outcomes of IT use, when such effects occur. This is not to say that technology is the only, or even the most important, contributor to IT effects, but merely that it may matter. Unfortunately, few scholars have picked up on these concepts, perhaps because of criticisms leveled against AST (Jones, 1999b; Jones and Karsten, 2008) by proponents of Giddens' structuration theory, which was an inspiration for AST. AST has been much more heavily used by scholars for another novel concept—that of users' appropriations of technology—than for the concepts of structural features and spirit.

There are compelling reasons to revisit the concepts of structural features and spirit at this time. First, the concepts of structural features and spirit were developed expressly to support the study of IT effects, which is foundational to a large part of the information systems research enterprise. In particular, IS design science (Hevner et al., 2004; Markus et al., 2002; Walls et al., 1992), which is currently attracting much attention, requires a robust program of research on IT effects. Second, scholars have bemoaned the lack of focus on the "IT artifact" in recent IS research (Benbasat and Zmud, 2003; Orlikowski and Iacono, 2001); their calls for better conceptualizations of information technology and its role in IT outcomes are widely cited. Any new attempts to conceptualize the IT artifact should surely be informed by DeSanctis and Poole's pioneering contributions. Third, the need to tease out what it is about technology that may be consequential is not unique to IS research but is also important in a variety of other domains, such as innovation research (Downs and Mohr, 1976; Fichman, 2002). Revisiting the concepts of structural features and spirit may shed new light on old topics.

Our analysis in this paper rests on two assumptions. First, we assume, as did DeSanctis and Poole (1994), that information technology is a socio-technical assemblage. As an artifact—that is, because it is built by people—IT is the product of social processes. However, some of the heterogeneous (Law, 1990) components from which IT is "assembled" (Latour, 2005) are physical or material. For example, a group support system may encompass rooms with desks and chairs, computer workstations, servers, network components and cables, software, and a large electronic display screen plus projection technology.

Second, we assume, as did Poole and DeSanctis (2004), that an IT artifact can be (but is not always) a contributing cause of IT use patterns and second-order effects, both positive and negative, such as improved decision-making or conflict suppression. There is considerable controversy in sociological circles about whether technology can be causal;[1] many scholars assert that the consequences of technology use must be attributed solely to human agency (Giddens, 1979; Grint and Woolgar, 1992; Woolgar and Grint, 1991). We argue, however, that much of the information systems research program, especially design science, is meaningless without the assumption that IT artifacts can be "actors"—that

[1] Some of the controversy reflects different meanings of the term "causal," a point to which we return later in this paper.

is, that they can have “agency” in the sense that they can (but do not *necessarily*) “modify a state of affairs by making a difference” (Latour, 2005, p. 71).

Our goal in this paper is to reexamine DeSanctis and Poole’s (1994) two technology-related concepts of structural features and system spirit for use in research on the behavioral and social effects of IT use. The question we ask is this: *How can we conceptualize IT artifacts in ways that help us hypothesize about, and investigate, their potential effects?*

The plan of the paper is as follows. We first describe AST as the context in which the concepts of structural features and spirit were developed. We next analyze the key contributions of, and the key concerns about, the structural features and spirit concepts. It is these concerns that we hope to address by redefining the concepts. Next, we examine how similar goals and concerns have been addressed in two other literatures in which artifacts play important roles: diffusion of innovation theory and ecological psychology. From this analysis, we derive some helpful strategies for addressing concerns about structural features and spirit. In the concluding section of the paper, we propose a redefinition of structural features and spirit as three new concepts—technical objects, functional affordances, and symbolic expressions—and we outline how these concepts may be used in future IT effects studies.

2. Background on Adaptive Structuration Theory

In the 1980s, Gerry DeSanctis and her colleagues at the University of Minnesota began a program of research on group decision support systems (GDSS or GSS), a class of systems designed to improve group processes by incorporating the results of scientific research and practical knowledge, such as the Nominal Group Technique. Their research program involved constructing a system, evaluating it, and conducting in-depth observations of groups using the system in experimental settings. The initial purpose of the research was to determine whether use of the system actually improved group processes, as the system’s designers had intended. Later, the focus of the research became explaining the processes by which users appropriated the system to their own goals, which sometimes resulted in unintended outcomes. Thus, the essence of this work was to explore the links between technology, technology use, and consequences.

In one of the most widely cited papers in the information systems field, DeSanctis and Brent Gallupe proposed a theoretical foundation that became the starting point for most subsequent work on GSS (DeSanctis and Gallupe, 1987). This paper identified the decision-making needs of groups, the corresponding features of systems that could address those needs, and the hypothesized outcomes of the use of systems with those features. Among the examples given of groups’ problems or needs are these: reluctance of some members to speak, failure to organize and analyze ideas efficiently, and failure to stick with the meeting plan. Examples of GSS features included anonymous input of ideas, summary and display of ideas, and continuous display of an agenda. GSS were hypothesized to have effects on member participation, patterns of information exchange, members’ perceptions of physical proximity and group cohesion, and member power and influence.

As the evaluative research progressed, the research team learned that the effects of system use varied across groups in ways that could not be explained by the technology alone. Although other scholars attributed such inconsistencies to methodological problems, DeSanctis and her collaborator Marshall Scott Poole proposed a better theory of the relationship between technology and its effects (DeSanctis and Poole, 1994). In so doing, they were entering contested intellectual terrain.

2.1. An Attempt to Integrate Determinism and Institutionalism

In a paper nearly as heavily cited as the “GSS Foundation” paper, DeSanctis and Poole (1994) identified two major schools of thought about the role technology plays in behavioral and social effects. The “decision-making school” is characterized either by “hard-line determinism—the belief that certain effects inevitably follow from the introduction of technology”—or by “more moderate contingency views, which argue that situational factors interact with technology to cause outcomes” (1994, p. 123). In contrast, the “institutional school” sees technology as “an opportunity for change, rather than as a causal agent of change,” wherein “people generate social constructions of technology" and "the creation, design, and use of advanced technologies are inextricably bound up with the form and direction of the social order" (p. 124). The problem for the decision-making school is that the research literature does not reveal "clearcut patterns indicating that some technology properties or contingencies *consistently* lead to either positive or negative outcomes" (p. 124, emphasis added). But the institutional school's approach "underplays the role of technology in organizational change … ignoring the potency of advanced technologies for shaping interaction and thus bringing about organizational change" (p. 124). "*There is no doubt,*" they argued, "that technology properties and contextual contingencies can play critical roles in the outcomes of advanced technology use" (p. 124, emphasis added).

Between these problematic extremes, DeSanctis and Poole (1994) identified an integrative third school of thought. This perspective, termed the "social technology" view, embodies "soft-line" determinism—"the view that technology has structures in its own right but that social practices moderate their effects on behavior" (p. 125). DeSanctis and Poole critiqued several such social technology models before introducing Adaptive Structuration Theory (AST), which considers "the mutual influence of technology and social processes" (p. 125). Inspired by the work of Giddens (1979), DeSanctis and Poole posited the concepts of social structures embedded in technology and social structures in action and then considered the interplay between them. The social structures embedded in technology were characterized in terms of the concepts of *structural features* —"specific types of rules and resources, or capabilities, offered by the system"—and *spirit*—"the general intent with regard to values and goals underlying a given set of structural features" (1994, p. 126). Variations in the social structures in technology were seen as encouraging different forms of social action, such as different group decision processes. However, the ways in which people actually used the social structures of technology (appropriated them) were seen as influencing the outcomes actually observed. In particular, people might appropriate a system's features faithfully–that is, in a manner "consistent with the spirit and structural feature design" (p. 130)—or unfaithfully, leading to different consequences.

2.2. A Conception of IT as a Cause of Individual and Social Behavior

At its core, AST hypothesizes a link—not a consistent association, but a link nonetheless—between these embedded structures and IT effects. "Prior to the development of an advanced technology, structures are found in the institutions such as reporting hierarchies, organizational knowledge, and standard operating procedures. Designers incorporate some of these structures into the technology…" (DeSanctis and Poole, 1994, p. 125). And, one might add, designers do this because they hope to bring about certain effects, such as improving group processes by means of a GSS. Although acknowledging that advanced information technologies "cannot fully determine" outcomes such as organizational change, DeSanctis and Poole contended that technology "can serve to trigger" such outcomes (p. 131). Together with spirit, "the structural feature sets of an advanced information technology form its *structural potential*, which groups can draw on to generate particular social structures in interaction" (p. 127, original emphasis, footnote deleted). In particular, the concept of structural features helps researchers hypothesize about what users can do with a technology and, thus, how the technology can make a difference, if and when it is used. Consequently, the concept of structural features is an indispensable tool for hypothesizing about and describing technology use and outcomes (Jasperson et al., 2005).

Although DeSanctis and Poole recognized that the effects of IT use depend on human agency, that is, users' appropriations, they also viewed IT as causal. This can perhaps be seen most clearly in their analysis of IS research on structuration theory ten years after their major publication on AST:
"Some argue that deterministic thinking has no place inside structuration models (e.g. Jones 1999). We disagree. … The inclusion of deterministic logic allows the IS research agenda to be not only reflective but also anticipatory. This is important because IS scholarship is interested not only in describing the unfolding of human-technology interaction but also in anticipating the consequences of technology adoption and its use and in providing systems development advice where possible. Structuration theory can help the IS field to move beyond purely deterministic views of technology, but it does not demand that we abandon causal logic altogether." (Poole and DeSanctis, 2004, p. 211)

To understand DeSanctis and Poole's perspective on this critical issue, it is useful to know that philosophical disagreements about the causal role of IT are often complicated by different conceptions of causation.[2] The traditional view, often referred to as positivist, holds that causation can be inferred when the outcome is regularly preceded by the cause, and spurious associations have been eliminated. This is the type of causality tested for in statistical analyses, where consistent associations are offered as evidence of causal relationships, and the absence of empirical regularities is taken as meaning that there is no causal relationship. In such a view, both IT artifacts and human actions may be understood as "causing" the effects observed. By contrast, a view commonly held by postmodernists and social constructivists is that the very notion of causality is an invalid application of a natural science concept to the social science domain. In the strongest versions of this view, only human intentions and actions (agency) can properly be thought of as explanations for social phenomena. For instance, in Giddens' structuration theory, "… anything other than his strong conception of [human] agency amounts to a form of determinism" (Jones and Karsten, 2008, p. 127) and, hence, is unacceptable.

A distinct third view of causality—the critical realist view—eschews the view of causality as observed empirical regularities. In this view, objects (including people, material objects, and social phenomena such as institutions) and relations among objects (for instance, friendship or master-slave relations) are viewed as having causal potential, but whether or not this potential is realized in actuality may depend on many other conditions, such as the behavior of other objects. Further, the realization of causal potential may not always be empirically observable. Thus, in critical realist ontology, causality does not depend on the researcher's observation of empirical regularities, or indeed on the researcher's beliefs or social constructions, although there are inevitable limits on human knowledge about causation. Because critical realism emphasizes explanation rather than prediction, this approach consists mainly in asking what about objects and conditions could have led to the outcomes empirically observed. This type of reasoning could be very useful in teasing out what role (if any) IT plays in observed IT uses and consequences. While seeking to identify the necessary conditions for observed outcomes, the critical realist pursues hermeneutic interpretation of actors' meanings and intentions and seeks to contribute to human self-awareness and political freedom, like other critical theorists. This change-oriented mission makes critical realism a suitable ontology for IS design scientists.

From this all-too-brief comparison, it should be clear that the premise of AST that technology can be *a contributing* cause (though rarely, if ever, the sole cause) of patterns of IT use and consequences is much closer to the critical realist position than to those of positivism, interpretivism, or postmodern theories such as Giddens' theory of structuration. On the other hand, DeSanctis and Poole's preoccupation with consistency of findings about IT effects is more aligned with a positivist, than with a critical realist, position, because critical realists focus on identifying the necessary conditions for the occurrence of certain effects, rather than regular associations between causes and effects. These observations should be borne in mind as one evaluates the contributions and limitations of DeSanctis and Poole's concepts of structural features and spirit, the task to which we now turn with the aim of putting the concepts on a sounder conceptual footing.

3. What About IT May Matter: Structural Features and Spirit

DeSanctis and Poole believed that something about IT makes a difference in terms of IT effects, and they characterized that something in terms of two new concepts: structural features and spirit. Structural features, also called "functional features" (DeSanctis et al., 1994), were described as "rules and resources," using Giddens' (1979) language of structuration, and also as functional information-processing capabilities—such as anonymous idea recording in a GDSS. Spirit was defined as "the general intent with regard to values and goals underlying a given set of structural features" (DeSanctis and Poole, 1994, p. 126). For instance, one system's spirit may reflect orderly conflict management and equality of participation while another's may reflect chaotic conflict management

2 This description draws on numerous sources, including Bhaskar (1975; 1998), Bunge (1996; 1998), George and Bennett (2005), Mingers (2004), Ragin (1987; 2000), Sayer (1993; 2000), and Smith (2006).

and domination. Spirit was seen as neither the designer's intention nor the user's perception, but rather as "a property of the technology as it is presented to users"—a property that is best identified by the researcher "treating the technology as a 'text'" (p. 126).

Below, we discuss how the concepts of structural features and spirit have contributed to the conceptualization of IT. We then describe the concerns and problems that confront researchers who try to apply DeSanctis and Poole's insights in studying IT effects.

3.1. Contributions of DeSanctis and Poole's Concepts

In his editorial comments on the AST paper, Bob Zmud wrote: "[DeSanctis and Poole] have laid an extremely strong foundation for future scholarship exploring … the organizational impacts of advanced information technologies" (quoted in DeSanctis and Poole, 1994, p. 121). In our analysis, the concepts of structural features and spirit make three specific contributions to that research program.

First, structural features and spirit offer clear alternatives to two of the most common ways of characterizing IT artifacts—in terms of designers' intentions and users' perceptions—each of which poses specific practical problems for researchers who study IT effects (DeSanctis and Poole, 1994). *Designers' intentions* may not be faithfully executed in the built artifact (Griffith, 1999), and built IT products may incorporate capabilities that are irrelevant, or even hostile, to achieving the designers' intentions. *Users' perceptions* or interpretations of systems are problematic, because they "are likely to capture only limited aspects" of the system (DeSanctis and Poole, 1994, p. 126), and thus may not be related to important system effects.

More fundamentally, these two familiar ways of characterizing IT do not help a researcher formulate hypotheses that are good enough to support design-oriented research about the probable effects of an IT artifact, when used; good hypotheses for design research attempt to identify *the particular attributes of an IT artifact* most likely to contribute to particular effects. DeSanctis and Poole's innovative alternative relied on *researchers* (not users) to describe systems and to do so in terms of *hypothesized links between aspects of a system and the consequences likely* to occur when a system with those properties is used. They argued that researchers would be able to make informed guesses about the probable effects of systems and about which system capabilities would contribute to those effects by closely "reading" systems and related materials, such as design documents and training materials.

Second, DeSanctis and Poole recognized the shortcomings of another common approach that does focus directly on the attributes of IT artifacts: feature lists. Feature lists are problematic, in part, because they do not focus attention on what is truly important about the technology: "Most systems are really 'sets of loosely bundled capabilities and can be implemented in many different ways'" (Gutek et al., 1984, cited in DeSanctis and Poole, 1994, p. 126). In addition, "systems vary so much in the presentation of their features that information based on features alone makes it virtually impossible to compare systems or versions of systems" (DeSanctis et al., 1994, p. 333). These differences in bundling, implementation, and presentation make it difficult for researchers to know a priori how detailed their descriptions of IT artifacts need to be. DeSanctis and Poole referred to this as the "repeating decomposition problem: there are features within features … . So how far must the analysis go to bring consistent, meaningful results?" (DeSanctis and Poole, 1994, p. 124). DeSanctis and Poole proposed replacing lengthy feature lists with a "more parsimonious" description in which researchers "scale technologies among a meaningful set of dimensions that reflect their social structures" (p. 126), thus focusing attention on what users are able to do with systems. They cited as examples of such an approach DeSanctis and Gallupe's (1987) three categories or levels of GDSS and Silver's (1991) characterization of decision support systems (DSS) based on the restrictiveness of their feature sets. In the scaling approach, features may be represented as bundles of functionality, thus obviating the need to look at individual features and sidestepping the repeating decomposition problem.

DeSanctis and Poole also suggested analyzing structural features by differentiating core and optional features (DeSanctis et al., 1994); this, too, is a substitute for characterizing systems in terms of lengthy feature lists. “Core” features were defined as “basic” or as those features that make a technology identifiable as a certain type of technology. Core to an electric washing machine, for example, are features for automatic entry of water, agitation, and high-speed spinning of clothes; choice of washing cycle time, adjustable legs, and bleach holders, by contrast, are optional. The implication is that identifying core and optional features should help researchers hypothesize about a system’s likely effects. For example, it seems logical that core features like clothes spinning are directly related to the effects of washing machines vs. washing by hand, whereas optional features like bleach holders are largely irrelevant.

Third, the concept of spirit embodies the twin insights that 1) for the study of IT effects, systems must be analyzed with consideration to *human values* and 2) the values supported by systems must be characterized *holistically,* in the sense that values are understood as properties of the system, not of its components. Indeed, DeSanctis and Poole noted, “When considering spirit we are more concerned with questions like, ‘What kind of goals are being promoted by the technology?’ or ‘What kind of values are being supported?’…” (DeSanctis and Poole, 1994, p. 127). That values must be considered when analyzing IT effects is clear, because designers often try to promote their own values such as efficiency, aesthetics, democracy, or panoptic control. That values must be considered holistically is clear from Poole’s earlier writings on organizational climate, where he noted, “‘Featurization’ can often do violence to the representation of climate as a holistic phenomenon because there is always much more to a context than can be encompassed by any list of dimensions or attributes” (Denison, 1996, p. 628). In perhaps their most intriguing comment on the concept of spirit, DeSanctis and Poole noted that technologies may lack coherent spirits as indicated by contradictions among the sources of information used to assess spirit. They hypothesized that systems with coherent spirits “would be expected to channel technology use in definite directions,” whereas “an incoherent spirit would be expected to exert a weaker influence on user behavior” (DeSanctis and Poole, 1994, p. 127). In short, the concept of spirit supports a holistic value analysis of systems.

3.2. Concerns about DeSanctis and Poole’s Concepts

Every pioneering conceptualization needs to be tested; articulating concerns about a theoretical framework is the first step toward resolving them. We mention three problematic aspects of the concepts of structural features and spirit that need to be addressed if researchers are to employ DeSanctis and Poole’s approach more fully than they have to date in studies of IT effects.

A first concern about the concepts of structural features and spirit centers on the underlying assumption that IT has “embedded social structures.” The belief that any object (human or non-human) has intrinsic causal properties (called “essentialism”) raises debates that go back to ancient Greek philosophers (Sayer, 2000). In recent years, postmodernists (for example, Bridgman and Willmott, 2006; Grint and Woolgar, 1992; Grint and Woolgar, 1995; Grint and Woolgar, 1997; Rappert, 2003) have been scathingly critical of scholars who argue that something about IT artifacts themselves (as opposed to people’s perceptions of, and shared beliefs about, those artifacts) can be consequential (Hutchby, 2001; Hutchby, 2003; Kling, 1991; Kling, 1992; DeSanctis and Poole, 1994).

More particularly, DeSanctis and Poole’s notion of “embedded social structures” has been criticized by Jones (1999b; Jones and Karsten, 2008) as an unfaithful appropriation of Giddens’ structuration theory. According to Jones (1999b; Jones et al., 2004), Giddens believes that “social structures *do not exist independent of human action*, *nor are they material entities*. He describes them as ‘traces in the mind’ and argues that *they exist only through the action of humans*” (Jones, 1999b, p. 105, emphasis added).[3]

[3] Because of this criticism, Orlikowski, who had originally also employed the notion of embedded structures in her theorizing (Orlikowski, 1992), later abandoned it (Orlikowski, 2000).

Despite this concern, numerous scholars, including Jones (1999a) as well as Poole and DeSanctis (2004), Chae and Poole (2005), Jones (1999a), Kallinikos (2002a; 2002b), Markus (2005), Orlikowski (2005; Orlikowski and Iacono, 2001), Rose et al. (2005), and Smith (2006), have argued that it is problematic that a theory as influential in the IS field as Giddens' structuration theory does not address the materiality of IT. Several approaches have been proposed for dealing with the omission, including practice theory (Orlikowski, 2000; Orlikowski, 2005), a "technology-shaping" approach (Markus, 2005), the integration of structuration theory with actor-network theory (Chae and Poole, 2005; Rose et al., 2005), and the reestablishment of structuration theory within a critical realist ontology (Jones, 1999a). A thorough analysis of these various proposals would be a paper in itself, so we confine ourselves here to just two points.

First, proposals to integrate Giddens' structuration theory with actor-network theory (Chae and Poole, 2005; Rose et al., 2005) undermine the basic AST assumption that IT itself can play a causal role. Although actor-network theory considers both IT and people to be "actors," actor-network theory is a postmodern, anti-essentialist theory (Rappert, 2003) that does not view technology as a cause (Latour, 1994; Latour, 2005).

Second, proposals to reestablish Giddens' structuration theory within a critical realist ontology (Jones, 1999a) are unnecessary. Although Jones (1999a) argued that conceptualizing IT as having causal potential by virtue of its material nature would do violence to Giddens' view of social structures as memory traces, he also noted that Giddens' position on the ontological status of social structures has itself been criticized and is probably a dispensable feature of structuration theory (Jones and Karsten, 2008). Even more to the point, DeSanctis and Poole have arguably *already* reestablished Giddens' structuration theory within a critical realist ontology through AST's assumption that IT has causal potential by virtue of embedded social structures.

In short, although we believe the debates over the philosophical foundations of AST (and IS in general) are important, we do not believe that they should stand in the way of serious attempts by other scholars to engage the concepts of structural features and spirit in studies of IT effects. Successful engagement, however, requires addressing two other concerns, discussed below: the repeating decomposition problem and the conceptualization of spirit as a property of systems that is independent of structural features.

A second concern centers on DeSanctis and Poole's analysis of structural features 1) by distinguishing core and optional features or 2) by "scaling" features on hypothetically relevant dimensions. Neither approach is an entirely satisfactory solution to the "repeating decomposition" problem that DeSanctis and Poole themselves raised.

The core vs. optional features distinction made by DeSanctis and Poole implies that core features matter when studying effects and optional features do not. However, whether or not a core feature is present in a system may not matter so much as *how* that feature is implemented technically. For example, whether or not a system provides a "graphical display of preferences"[4] may not be so consequential as whether the display of preferences is graphically represented in the form of a graph or a table. To be fair, such implementation differences were a non-issue in DeSanctis and Poole's studies, which compared subsets of the same system in which there was no variation in how particular features were implemented. However, implementation differences may be enormously important in a study comparing two different instances of the same system type (for instance, SAMM vs. Group Systems)—a type of study that is sadly neglected in IS research (Markus, 2005). Furthermore, how features are implemented is of great importance to system developers; so, if a researcher's purpose is to inform design, researchers may have to describe systems at the implementation level of detail. Thus, the analysis of structural features for studying IT effects cannot be easily confined to features considered "core."

On the other hand, DeSanctis and Poole's "scaling" option, which involves assessing technologies on

[4] Cf. DeSanctis et al. (1994), Table 1.

holistic dimensions such as "restrictiveness," "comprehensiveness," or "sophistication," is also less than satisfactory as a solution to the repeating decomposition problem. Not only are these scales difficult to differentiate analytically from dimensions of spirit—such as the type of decision promoted, the likelihood of leadership emergence, or potential efficiency effects (DeSanctis et al., 1994)—but they do not capture a key aspect of structural features for studying system effects, namely, functionality—what the technology enables users to do with it. Thus, these scales must be supplemented with a functional analysis, for which there is no clear stopping rule.

The third and most problematic concern about DeSanctis and Poole's conceptualizations is their positioning of spirit as a "property of the technology" (DeSanctis and Poole, 1994, p. 126) defined in terms of "general intent" and "goals and values" and not directly related to a system's structural features. The attribution of human qualities like "intent" and "values" to artifacts troubles many analysts, including realists, as well as post-modernists such as Jones (1999a), Latour (2005), and Pickering (1995). Regardless of what one thinks of structural features as technology properties, the idea of intents and values as embedded properties of technology is ontologically troubling, because it implies that technology, a human artifact, can have values and intentions that are independent of those of its creators and users. The concept of spirit is, thus, especially challenging to understand, since it was explicitly described as neither the designers' intentions nor the users' perceptions. We share DeSanctis and Poole's insight that something about technology *may be interpreted by users or researchers as intents and values*, but we have difficulty with the notion that intents and values are embedded properties of systems.

Recap

Table 1 summarizes the contributions of, and concerns about, DeSanctis and Poole's concepts of structural features and spirit. As a foundation for the study of IT effects to support a robust IS design science, the contributions clearly outweigh the concerns. At the same time, unanswered questions and missing theoretical linkages make it difficult for other researchers to apply these innovative concepts. In the next section, we show that the study of innovation diffusion has faltered on some of the same points, and that the relational concept of "affordance" from ecological psychology may combine with "appropriations" to provide a useful bridge between the analysis of IT properties and the explanation of IT effects.

4. Other Approaches to Characterizing Socio-Technical Artifacts

Challenges similar to the ones described above have been confronted in other literatures. We consider diffusion of innovation research and ecological psychology, both of which suggest the potential usefulness of concepts that bridge between objects and the people who use them.

4.1. Diffusion of Innovations

It is common practice today in the IT diffusion and technology acceptance literatures to characterize innovations by measuring adopters' perceptions of the technology—for instance, "perceived relative advantage" and "perceived ease of use." Fichman (2002) attributed this practice to an influential paper by Downs and Mohr (1976), who were concerned about the "instability" of the findings in innovation research, just as DeSanctis and Poole (1994) were concerned about the lack of "consistency" of findings in GSS effects research. Like DeSanctis and Poole, Downs and Mohr noted that successful theoretical descriptions and explanations of innovations may be particular to specific innovation types (1976, p. 701).

According to Downs and Mohr (1976), innovations can be characterized in two main ways, in terms of *primary* or *secondary* characteristics. Primary characteristics are understood as "'*essential* to the object and so are *inherent* in it whether they are perceived or not'"; secondary qualities are those "'perceived by the senses, and so may be differently estimated by different percipients'" (Jeans, 1966, cited in Downs and Mohr, 1976, p. 703, emphasis added). In other words, what we have been referring to as IT properties or embedded structures are primary characteristics; users' perceptions of an IT artifact are secondary characteristics.

Table 1. Structural Features and Spirit—Contributions and Concerns	
Contributions	**Concerns**
Structural features and spirit provide clear alternatives to common characterizations of IT artifacts in terms of designers' intentions and users' perceptions. Structural features and spirit characterize IT in terms of IT capabilities believed (by the researcher) likely to cause particular effects.	Some social theorists reject all belief in essential properties, whether of people or of physical objects. In particular, AST has been criticized for postulating social structures embedded in technology, a belief that directly contradicts a core premise of Giddens' structuration theory, which was a source of inspiration for AST.
Analyzing structural features by 1) scaling technology on various dimensions and 2) differentiating core and optional features is a significant improvement over the use of feature lists, because these approaches reduce the problem of repeating decomposition and focus attention on likely sources of effects.	Neither the feature "scaling" solution nor the core versus optional features distinction is an entirely satisfactory approach for dealing with the repeating decomposition problem. Whether or not a feature matters depends not only on its presence or absence but how it is implemented. The scaling option overlaps with the concept of spirit and addresses values, but does not address functionality at a level that relates clearly to users' appropriations of technology.
The concept of spirit enables the researcher to 1) analyze the values that IT can promote and 2) analyze systems holistically. That systems may have "incoherent" spirits and conflicts between their functional capabilities and "values" are interesting insights.	The most problematic issue is the conceptualization of spirit as a property of a system defined in terms of intents, goals, and values—which are human properties. In addition, important questions about the operationalization of, and the relationships between, structural features and spirit remain unanswered.

The ironic legacy of Downs and Mohr's (1976) paper has been the widespread use of secondary characteristics (that is, users' perceptions) as descriptors of IT innovations (Fichman, 2002). However, this outcome is very different from what Downs and Mohr recommended. They argued that secondary characteristics, while useful, are better understood as descriptions of *adopters*, not of *innovations* (Downs and Mohr, 1976). And, despite the problem with primary characteristics—that "an innovation is rarely the same thing to two different organizations" (p. 704)—primary characteristics too are useful, as long as the researcher does not try to generalize research findings to innovations that differ in primary characteristics (p. 712). The ultimate solution, they concluded, was to include *both* primary and secondary characteristics in innovation studies. In addition, they argued that researchers should use "interactive models" that combine both primary and secondary characteristics, in what they called "the single most important departure from current [research] practice" (p. 712).

We conclude from our reading of Downs and Mohr that the main objection to the use of IT artifact properties in studies of IT use and effect—that the researcher is unlikely to find strong correlations between primary characteristics and outcomes because of differences among adopters—is only a problem if one holds the traditional positivist conception of causality as regularity of occurrence. If, on the other hand, one does not expect that the causal potential of IT will always be realized because of the presence of many other conditions (the critical realist view of causality), these objections disappear. We also draw attention to Down and Mohr's "interactive models," which are highly suggestive of the relational concept of "affordance" from ecological psychology, described below.

4.2. Ecological Psychology

How to characterize material objects and artifacts is also a central challenge for ecological psychologists, who, following the pioneering work of J.J. Gibson (1977), seek to understand the behavior of animals (including humans) in their environments. Impressed with animals' skillful activity in finding food, shelter, and so forth, ecological psychologists rejected the view, common in their day, that animals and humans perceive *impoverished sensory information*, such as points of light of particular wavelengths and intensities, from which they *construct rich mental representations* or images of objects (Michaels and Carello, 1981). Ecological psychologists believed instead that animals and people directly "pick up" rich information that is relevant to their needs from the objects in their environment. In this conception, animals and people perceive, not the *properties* of objects, but rather the "*affordances*" of objects, defined as "the acts or behaviors that are afforded or permitted by an object, place, or event" (Michaels and Carello, 1981, p. 17). "We would say that humans do not perceive chairs, pencils, and doughnuts; they perceive places to sit, objects with which to write, and things to eat" (p. 42).

Ecological psychologists are realists who believe that "there are perceivable objects and events whose existence does not depend on being perceived or thought about"[5] (Michaels, 2003, p. 86). They assume that objects have properties that are responsible for the information they give off: "There necessarily exists some information that is specific to its source" (Michaels and Carello, 1981, p. 17). However, ecological psychologists reject the reductionism (repeating decomposition) traditionally associated with realism. "Traditional descriptions of stimuli are in terms of very low-level physical variables, the metrics of sound or light a physicist would use" (p. 9), reflecting the reductionist belief that finer grained analyses provide more accurate or realistic depictions of the environment. To ecological psychologists, reductionist descriptions of objects, stimuli, and environments are *impoverished descriptions*. Instead, Michaels and Carello (1981) claimed, "The realism [of ecological psychology] is one in which the real nature of the environment can be described with reference to the … *goal-directed* behavior … of the animal." (p. 106, emphasis changed). Thus, the concept of affordances allows ecological psychologists to describe environmental objects—including artifacts, "the human-made environment" (p. 55)—at a scale or "grain" that is appropriate to the animal–environment system being studied by means of focusing on animals' goals.[6]

Naturally, to describe affordances in these terms requires the researcher *to specify the animal for which an object is an affordance* (Michaels and Carello, 1981). Affordances for the members of one species may be completely useless to members of another. (Even within a species, members can differ in their abilities to perceive certain environmental information as useful, for example, because of differences in their body sizes.) It is also critical to specify an animal's action-oriented goals and characteristics or abilities. An object with one affordance (for example, a hollow tree truck that affords hiding) may not afford a different goal-directed action (for instance, eating). An object that affords hiding to a small animal may not provide the same affordance to a large one.

As with the structural features and spirit of AST and the primary and secondary characteristics of innovation theory, the formal definition and ontological status of affordances have been subject to considerable debate. (See the special issue edited by K.S. Jones, 2003.) Some have defined affordances as the inherent properties of objects, but others have argued persuasively that affordances are *emergent* properties of the animal-environment *system* (Stoffregen, 2003) or *relations* between the features of a situation and the abilities of animals or people (Chemero, 2003). In this view, the real properties of objects are *necessary conditions* for affordances, not the affordances themselves (Heft, 2003). Moreover, affordances have to be perceived by an animal before they can

[5] By contrast, the mainstream psychological theory of indirect perception "holds that the properties of objects owe their existence, at least in part, to being perceived" (Michaels, 2003, p. 86).
[6] Note that "goal" in ecological psychology is not equivalent to "intention" as in the theory of planned behavior. The former term does not presume reflective decision-making; the latter does.

be acted on; therefore, affordances are *potentials* for action that may not occur. But affordances are understood to be "perfectly real and perfectly perceivable" (Chemero, 2003, p. 191), "as long as some animal exists with the appropriate ability" to perceive and make use of them (p. 193). In short, conceptualizing affordances as potentially necessary relations between animals and objects, rather than as properties of objects, helps to explain the inconsistencies in findings that have troubled researchers in several fields.

4.3. Implications

Like the field of information systems, both innovation studies and ecological psychology have faced the challenges of describing objects and artifacts in ways that help explain their uses and effects. The two fields resolved the challenges in strikingly similar ways. Both schools concluded that the properties of artifacts are *relevant* to explanation, but that alone they are *insufficient* for explanation. Both schools concluded that the relevant properties of artifacts differ depending on the type of actor and artifact and that the researcher must consider interactions between actors and artifacts in light of the actors' goals and capabilities.

Ecological psychology sheds a particularly interesting light on DeSanctis and Poole's conceptualization of IT. Ecological psychologists explain action non-deterministically in terms of the relational concept of affordances, for which the properties of objects are seen as necessary, but not sufficient, conditions. Environmental objects are believed to have properties that can provide affordance information, but affordances are not properties of objects. Because action is goal-oriented, it is neither required nor appropriate to describe objects and affordances in a reductionist fashion. Instead, they should be described at a "grain" that is appropriate for the animal–environment system. In the next section, we outline how these observations can resolve some aspects of DeSanctis and Poole's concepts for characterizing IT that are problematic for conducting IT effects studies.

5. Extending DeSanctis and Poole's Contributions

DeSanctis and Poole's (1994) concepts of structural features and spirit are an insightful starting point for developing descriptions of IT artifacts for purposes of explaining their likely uses and effects, but, as discussed above, the concepts need to be extended to yield fruitful hypotheses for IT effects research and IS design science. At the same time, extensions of these concepts must preserve the core insights that led to their creation, specifically, that IT artifacts should be conceptualized in a way that 1) avoids the limitations of feature lists, designers' intentions, and users' perceptions and 2) permits holistic analysis of technology on values dimensions, not just functional ones. In this section, we first describe the concepts we propose as extensions of structural features and spirit and then discuss how these concepts may be used in IT effects and design studies.

5.1. The Extended Concepts

Where DeSanctis and Poole (1994) proposed two concepts to describe IT artifacts (structural features and spirit), we propose three: technical objects, functional affordances, and symbolic expressions. The technical objects concept pertains to the IT artifacts themselves; the functional affordances and symbolic expressions concepts refer to *relations* between technical objects and users. Naturally, no explanation of IT effects would be complete without careful conceptualizations of users and use environments, but developing such conceptualizations is beyond the scope of this paper.

Technical Objects

We propose the concept of *technical objects* to denote IT artifacts and their component parts. So a given IT artifact comprises numerous technical objects, which may themselves be decomposed. Thus, GSS are technical objects, as are the GSS components that DeSanctis and Poole used as illustrations of structural (DeSanctis and Poole, 1994) or functional (DeSanctis et al., 1994) features, such as anonymous idea recording, electronic voting procedures, computer terminals for group members, gateways to networks or central computers, and large common display screens (DeSanctis et al., 1994, p. 593). Technical objects also include the "interface" through which users interact with IT artifacts and such interface components as pointing devices, icons, and menu labels.[7] In addition, we include in the technical objects concept the *outputs* of information systems, such as documents, drawings, transcripts, and representations, which are instances of the "boundary objects" discussed in the knowledge sharing literature. For example, Star and Griesemer (1989) explained that boundary objects, which may be concrete or abstract, have a structure that allows them to be recognizable across sites, although they may have different uses and meanings in each local site.

Consistent with realist and critical realist ontologies, we conceptualize technical objects as *real things,*[8] whether they are material things like printers or abstract things like representations on computer screens. As real things, technical objects have properties—for instance, a red color or the ability to disguise the identity of a communicator—some of which may have causal potential, where causal potential is understood to mean that a property may be a necessary condition for some outcome to occur. For example, technical objects must have material properties, such as mass, volume, and texture, for people to perceive and use them. Similarly, for people to use a word processor to prepare documents efficiently, the word processor must indeed be able to support the efficient preparation of documents. But, just because technical objects may be necessary for certain uses does not mean that this is how people will necessarily use them. Causal potential does not equate with deterministic outcomes.

As "real" entities, technical objects do not depend for their existence on being perceived by humans (in contrast with, say, "perceived ease of use"), although they must generally be perceived to be used.[9] Thus, the concepts of technical objects and properties are different from the concept of users' perceptions. Technical objects are artifacts—that is, they are made by humans. They are outcomes of intentional design and manufacturing processes. However, not all properties of technical objects are deliberately intended, because they may result from thoughtlessness, from conflicts among designers and other parties (Kallinikos, 2002b) or among design priorities, and from poor construction or unplanned interactions among components (Griffith, 1999; Griffith and Northcraft, 1994). Examples of possibly unintended technology properties include broken links, frequent crashes, and "defaults" preset to infrequently selected values, triggering errors. Thus, the concepts of technical objects and properties are distinctly different from the concept of designers' intentions.

The concept of technical objects is similar to that of structural features in that it addresses the causal potential "embedded in" technology. Our view of the properties of technical objects as necessary conditions for certain outcomes, is, we believe, consistent with the "soft-line determinism" underlying AST (DeSanctis and Poole, 1994). The technical objects concept differs from that of structural features, however, in that the causal potential of technical objects lies not only in their functionality, but also in such other properties as their packaging, arrangement, and appearances. For instance, the bulkiness of a device, the size of a display, the color and shape of toolbar icons, and the labels on features may be consequential for how users interpret and use IT artifacts and for the effects of IT use.

The concepts of technical objects and their properties are, we believe, essential for IT effects and design studies, because they can help explain the outcomes observed when technology is used. On their own, however, they make for poor explanations of IT uses and consequences. Not only is there the problem of how objects can be theorized as acting on people, but, because objects can be decomposed into smaller objects, there is no obvious way to limit their analysis, yielding the repeating decomposition problem that DeSanctis and Poole noted for feature lists. We added, therefore, the two relational concepts of functional affordances and symbolic expressions, discussed below, to help researchers make productive hypotheses about which of the many properties of any technical object may be related to the object's probable uses and consequences, without the hard-line determinism of

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[7] However, we exclude from our definition the meanings that these things may have for designers or users. See below.
[8] Bunge (1996) defined real as changeable, in contrast with Platonic "essences," which were seen as eternal concepts in a realm apart from, and higher than, matter.
[9] Newer technologies such as ubiquitous computing, wearable computing, and nanotechnology may have the potential to be activated without users perceiving them.

"expecting all results to be identical" (Downs and Mohr, 1976, p. 712).

Functional Affordances

Our concept of *functional affordances* is based on the concept of affordance from ecological psychology. Functional affordances are a type of relationship between a technical object and a specified user (or user group) that identifies what the user may be able to do with the object, given the user's capabilities and goals. More formally, *functional affordances* are defined as the possibilities for goal-oriented action afforded to specified user groups by technical objects. For example, a GSS may afford groups that want to make consensus decisions the opportunity to surface ideas anonymously and tabulate the results of straw polls quickly. The same system may afford nothing to a team run by an autocratic leader, whose goal is to avoid surfacing dissenting opinions, or to a team lacking access to a group facilitator or skills in using group process tools.

Like the concept of structural features, the concept of functional affordances gets at social structures that may be supported by an IT artifact, such as Robert's Rules of Order in a GSS, or particular engineering analyses in a 3D CAD system. But functional affordances differ from structural features in that the former concept is conceptualized as a relation between the object and a specified user group, whereas structural features were conceptualized as technology properties. The functional affordances concept also differs from DeSanctis and Poole's (1994) concept of appropriation moves. Whereas the appropriation moves concept refers to *actual* uses of an IT artifact, functional affordances refers to *potential* uses.

Because the concept of functional affordances is defined as a relation between a technical object and a defined user group, it can greatly reduce the repeating decomposition problem associated with analyses involving the concepts of structural features or technical objects. By analyzing the characteristics and goals of the user groups that are relevant to a particular inquiry, the researcher may be able to sharply limit the range of technical objects and properties examined in a given study. For example, Baxter (2008) concluded that only two key technical objects of the CATIA 3D CAD system were necessary for the changed work practices he observed in the construction teams for a recent Frank Gehry design project, relative to construction teams using 2D CAD systems: an XYZ coordinate system and Bezier/B-Spline equations for describing free-form curves. Thus, by reducing the need to decompose technical objects into ever-smaller units, the concept of functional affordances approaches the type of holistic analysis of IT artifacts that DeSanctis and Poole called for. However, a limitation of the functional affordances concept is that it focuses solely on issues related to technical functionality. Thus, the functional affordances concept does not support a *values-oriented* analysis of IT artifacts. For that purpose, we propose the concept of symbolic expressions, described next.

Symbolic Expressions

The concept of spirit was designed to capture "intents and values" as they are holistically presented to the user by a system. We earlier argued that it is problematic to conceptualize intents and values as properties of systems: Intents and values are concepts that most analysts are more comfortable attributing solely to humans, whether designers of systems or system users. In that case, the question of spirit becomes this: What about an IT artifact may enable its users to make interpretations of "the system's" (or its designers') values and intents? In other words, while we assume that users engage in processes of interpretation and social construction with respect to systems, we also assume that something in IT artifacts can contribute to (but not determine) users' impressions of systems.

We earlier defined that "something" as technical objects and their properties, which not only enable the functionality of IT artifacts, but also enable users to perceive, interpret, and interact with IT artifacts. There is a conceptual gap, however, between those technical objects and users' interpretations of them, just as there is a conceptual gap between technical objects and users' appropriations or uses of technology. We propose to fill the impressions gap the same way we earlier proposed filling the uses gap—with a relational concept linking the technical objects and a defined user or user group. Specifically, just as we proposed functional affordances as a relational concept bridging IT artifacts and what users may do with them, we propose the concept of symbolic expressions as a relational concept bridging IT artifacts and how users may interpret them.

We define *symbolic expressions* as the communicative possibilities of a technical object for a specified user group. In doing so, we draw on the ideas of semiotic engineers (practitioners and scholars who study interactive software), who view the interface as a source of "signs" that "have to *communicate* to users the design vision, and the particular code the system is prepared to interpret and react to …" (de Souza and Preece, 2004, p. 584, original emphasis). From this point of view, the interface is a "*message* from designers to users about how users must interact with the system in order to achieve a certain range of *goals* and experiences" (p. 584, emphasis added). Naturally, the messages of interest to IS researchers are not just limited to the interface, but may also come from other technical objects. Similarly, messages are not just limited to those that help users interact with IT artifacts, but may also include messages pertaining to designers' or users' goals and values.

Although systems generally express some of the messages intended by designers, they may also express messages that designers did not intend. Therefore, the concept of symbolic expressions differs from the concept of designers' intentions. Furthermore, the numerous symbolic expressions of an IT artifact are not necessarily perceived or heeded—they are only *potentially* communicated to users. Thus, the concept of symbolic expressions is also distinctly different from the concept of users' perceptions. What makes technical objects able to express messages to users, when and if they do, is their ability to serve as "signs." de Souza and Preece (2004, p. 583, citing Eco, 1976) defined signs as "anything that can be taken as significantly substituting for something else, whether this something else exists or not, is true or false, known or unknown." Things can only function as signs for members of shared culture or language communities. For instance "red" may mean "prosperity" to Chinese people, "communism" to Westerners, and "stop" to members of both communities. Along the same lines, emoticons have become substitutes for body language and emotions that are close to being "universally understood by the *computer literate population*" (p. 584, emphasis added). Interface designers make use of the languages and cultures they share with users to craft signs that are meant to convey certain meanings to users. For instance, shared language and culture enabled semiotic engineers to conclude that the MSN Messenger chat program slightly altered the meaning of "conventional 'signs' that are *completely familiar to any capable speaker of English* …" (p. 586, emphasis added). Thus the concept of symbolic expressions is clearly a relation between an IT artifact and a specified user group and, therefore, not a property of the artifact itself.

The concept of symbolic expressions is similar to the concept of spirit in two respects. First, both concepts refer to something other than designers' intentions or users' perceptions. Second, both concepts point to properties of IT artifacts that can convey impressions that users, designers, and researchers may *interpret* as values and intents. For instance, inflexibility and limited response options may lead users to view a package as "fascist," as we heard claimed years ago about *The Coordinator.*[10]

At the same time our concept of symbolic expressions differs from the concept of spirit in three respects. First, although we acknowledge technical objects as the source of symbolic expressions, we define symbolic expressions as a relational concept relative to a specific user group, not as properties of technical objects. Second, we do not limit the concept of symbolic expressions to the domain of values, but also use the concept to refer to expressions about functionality. For example, an artifact may express to a defined user group that it can be used to support 1) the value of democracy and/or 2) the activity of consensus building. Such expressions may be erroneous, as in a link to functionality that proves to be "under construction." And functional and values-oriented symbolic expressions may be in conflict with each other. But, defining the concept in this way has the advantage of supporting potential analyses of the relationships between functional affordances and symbolic expressions. Third, unlike spirit, the concept of symbolic expressions is not necessarily holistic. While spirit is presented as a property of the system as a whole, symbolic messages may relate to the artifact as a whole or to any of its component technical objects. Indeed, an artifact may have many different

[10] See Flores et al. (1988) for a description of The Coordinator.

symbolic expressions for a specified user group, just as it may have many functional affordances. And these various symbolic expressions may conflict with each other, a possible result of the numerous designers involved in building today's IT artifacts (Kallinikos, 2002b). We believe that examining the diversity of symbolic expressions is a useful way to investigate the potential "incoherence" of systems—an issue to which DeSanctis and Poole directed our attention. In short, we acknowledge important differences between our concept of symbolic expressions and that of spirit, but we believe our concept can be quite useful for the analysis of values related to IT artifacts in addition to being useful for explaining users' interpretations of, and interactions with, IT artifacts.

Summary

Table 2 summarizes our three conceptual extensions and compares them to DeSanctis and Poole's original concepts of structural features and spirit. Figure 1 illustrates our three concepts in relation to a user group. (Not shown is the other side of a more complete explanation of IT effects, in which users may appropriate the functional affordances of technical objects and may interpret their symbolic expressions.) In the next section, we discuss how our three concepts of technical objects, functional affordances, and symbolic expressions can be used in studying IT effects and design issues.

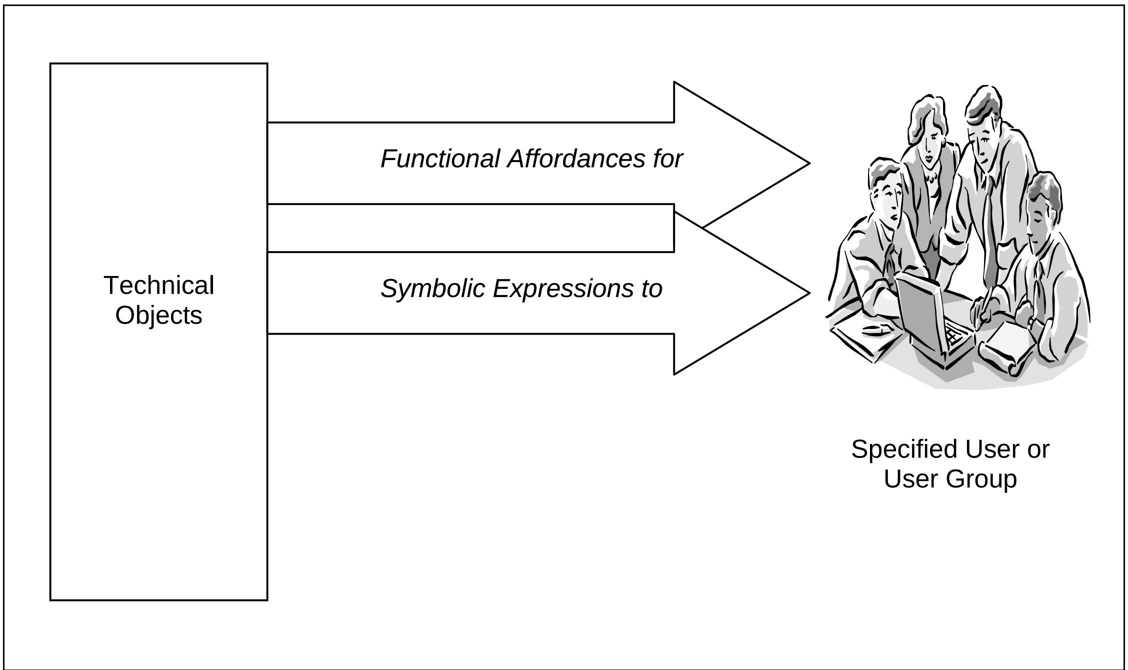

Figure 1. How Functional Affordances and Symbolic Expressions Relate Technical Objects to Specified Users or User Groups

Table 2. What About IT Matters—Conceptualizations Compared

Concept	Definitions and Explanations	Similarities to the Ideas of DeSanctis and Poole	Differences from the Ideas of DeSanctis and Poole
Technical Objects	• Defined as IT artifacts and their component parts • Understood as material and immaterial real things, the properties of which are potentially causal, that is, necessary conditions for people to perceive them and use them in particular ways with particular consequences • Understood not to depend for their existence on people's perceptions of them, thus not equal to users' perceptions • Understood as made by people, but not always intentionally, hence different from designers' intentions	• Similar in meaning to functional or structural features as "information processing capabilities" • Consistent with DeSanctis and Poole's assumption that IT artifacts have embedded causal powers • Consistent with DeSanctis and Poole's conceptualization of IT artifacts as equivalent neither to designers' intentions nor to users' perceptions • Similar to the concept of structural features in that it exhibits the repeating decomposition problem	• Different from the concept of structural features in that the causal powers of technical objects are understood to lie not only in functionality (information processing capabilities) but also in packaging, arrangements, and appearances
Functional Affordances	• The possibilities for goal-oriented action afforded by technical objects to a specified user group • Understood as relations between technical objects and users • Understood as potentially necessary (but not necessary and sufficient) conditions for "appropriation moves" (IT uses) and the consequences of IT use	• Similar to the conceptualization of structural features as offering potentials that users can draw on to create social structures • Similar to the analytic approaches (feature scaling and core/optional features distinctions) in proposing a solution to the repeating decomposition problem • Similar to the concept of structural features in that it does not provide a way to analyze the values issues related to IT	• Different from the concept of structural features in that functional affordances are viewed as relations, not as properties of technologies

Symbolic Expressions	• The communicative possibilities of technical objects for a specified user group • Understood as relations between technical objects and users • Understood as potentially necessary (but not necessary and sufficient) conditions for user interpretations of IT and the consequences resulting from those interpretations	• Similar to the concept of spirit in that symbolic expressions are understood neither as designers' intentions nor as users' perceptions • Similar to the concept of spirit in the attempt to support values analyses of IT artifacts	• Different from the concept of spirit in that symbolic expressions are understood as a relation between an object and a specified user group, whereas spirit is defined as a system property • Different from the concept of spirit in that symbolic expressions can refer to functionality as well as to values • Different from the concept of spirit in that symbolic expressions are not necessarily viewed as holistic
The Concepts Taken Together		• Similar to the concepts of structural features and spirit in providing an approach for characterizing what about IT matters for IT effects • Similar to the concepts of structural features and spirit in addressing both functionality and issues of values • Similar to the concepts of structural features and spirit in needing to be combined with other concepts (for example, user types, types of use contexts, user interpretations, faithful/unfaithful appropriations by users) to provide complete explanations for IT effects	• Different from the conceptualization of DeSanctis and Poole in proposing bridging concepts (functional affordances and symbolic expressions) between the IT artifact and users' appropriations and interpretations of it • Different from the conceptualization of DeSanctis and Poole in handling function/values conflicts; in DeSanctis and Poole's conceptualization, conflicts lie in the properties of a system, whereas, in our analysis, conflicts lie in the (functional and symbolic) relations between technical objects and a specified user group, suggesting a different approach to the analysis of system incoherence

5.2. How the Extended Concepts Can Be Used By IS Researchers

We start by noting that our goal in extending DeSanctis and Poole's concepts of structural features and spirit is to pursue Gerry's original goal of developing a foundation for the study of IT effects (DeSanctis and Gallupe, 1987). IS researchers may approach IT effects studies from a design science perspective, evaluating systems in use to learn whether designers' intentions were successfully translated into a useable and useful artifact and to inform further design efforts. Alternatively, they may approach the study of IT effects from a broader social or behavioral standpoint, inquiring about second-order effects or why system effects may differ across contexts. In either case, IT effects researchers make hypotheses, whether about the likely effects of artifacts with certain properties or about the properties of IT artifacts that may be associated with particular effects. In neither case is it necessary to assume an invariant or deterministic linkage between IT properties and IT effects: Conditions other than technology—users' characteristics and goals, their interpretations of technology, their work practices, and institutional contexts—may play key roles in causal explanations, and in any given case the properties of technology may not matter at all. But, even for the purposes of ruling out technology as part of an explanation, researchers need to be able to make high-quality hypotheses about technical properties that *may* have played a causal role.

DeSanctis and Poole developed the concepts of structural features and spirit with the aim of helping researchers make good hypotheses about IT effects, and our extensions of their concepts are intended to make researchers' hypotheses even better. At the same time, we realize, as DeSanctis and Poole noted about their concepts, that no single set of descriptors for technical objects, functional affordances, and symbolic expressions will work for every *technology*. The continual emergence of new technologies inevitably requires ongoing conceptual development.

We also note that different *study designs* for researching IT effects will also require different descriptions of IT artifacts. DeSanctis and Poole did not make this observation, possibly because their effects studies examined two different versions of the same GSS package. But the domain of IT effects studies also includes studies of different packages in the same general type (for instance, SAMM versus Group Systems in the GSS class and SAP versus JD Edwards in the ERP systems class), as well as studies of technologies of substantially different types (for instance, Group Decision Support Systems vs. Group Communication Support Systems, 2D vs. 3D CAD, or wikis vs. blogs).

When one considers the full range of study designs for researching IT effects, which DeSanctis and Poole did not do, the limitations of DeSanctis and Poole's suggestions for analyzing systems functionally—scaling systems on abstract dimensions such as restrictiveness and specifying core vs. optional features—become apparent. Abstract descriptors such as "restrictiveness" that may be very useful for distinguishing between two versions of the same system may not be concrete enough to provide analytic value when comparing across system types. Instead, one may need to understand that blogs restrict users in one way, and wikis restrict users in others. Similarly, the "core features" of ERP systems (for example, integration across functions) may be useful in explaining the different organizational effects observed for ERP systems vs. standalone applications, but it may be the "optional features" (for instance, "bolt-on" software particular to various industries) that are more useful in explaining any differences observed in the use and consequences of SAP vs. the JD Edwards ERP package. As another example, in studies of CATIA vs. another CAD package, it may be a non-core feature such as wire-frame vs. solid modeling that explains differences in outcomes, not the core features like the Bezier/B-Spline equations that differentiate 3D CAD systems from 2D CAD.

These observations suggest that applications of our concepts should start with careful attention to the types of comparisons the researcher seeks to make in an IT effects study, of which we may distinguish several kinds: 1) comparisons of a situation in which a system is used to one in which no system is used, 2) comparisons of situations in which different ways to implement a particular design feature are tested for specified users groups, for example, the road-map vs. Ferris Wheel interfaces discussed by Markus et al. (2002), 3) comparisons of situations in which different software packages of the same type (ERP systems, 3D CAD systems) are used, and 4) comparisons of situations in which different types of systems are used (email vs. instant messaging).

An additional consideration in IT effects study designs is that the technical objects a given IT artifact comprises may differ because of choices made after the artifact was first designed. For example, the organizations that install a software package can make potentially consequential configuration decisions such as the number of seats in a GDSS decision room or whether the GDSS software is only to be used synchronously in face-to-face meetings or whether the software can also be used by geographically distributed groups. Some IS researchers believe that "implementation parameters" such as these inevitably confound IT effects study designs and argue for idiographic research on the grounds that IT effects are inherently contingent. However, through careful analysis, implementation parameters can be a great boon in IT effects studies, by allowing researchers to construct "natural experiments" that can help identify the aspects of IT artifacts that actually make a difference for defined user groups.

This last observation highlights another key implication of our analysis. Regardless of study design, the investigation of IT effects cannot proceed very far without careful specification of the relevant users or user groups and the construction of hypotheses linking IT artifacts and those user groups. We have proposed two types of relationships linking IT artifacts and users—functional relationships and symbolic ones. By conceptualizing these as relations, we are effectively arguing that no matter how nifty the features of an IT artifact are, they are irrelevant if the focus of a study is on a user group that is unable to perceive or take advantage of those features. Put differently, every research hypothesis about a functional affordance or a symbolic expression must be warranted, not only by specifying the technical objects that may contribute to the affordance or expression, but also by specifying the user or user groups for which those objects are affordances or expressions.

It is important to note that this process of warranting does not have to degenerate into "featurization" or repeating decomposition. The researcher may hypothesize that the system as a whole, rather than one or more component parts, provides an affordance or an expression to a specified user group. That was the conclusion of a study that explored the effects both of individual features (for example, anonymous messages vs. identified messages) and of "media" ("constellations of communication channels," for example, GSS vs. face-to-face meetings). In a fully crossed experimental design, Griffith and Northcraft (1994) found significant main effects for both features and for media, as well as significant interaction effects. Griffith and Northcraft's results suggest that functional affordances (and possibly also symbolic expressions) may result from synergies or interferences among technical objects.

The key to better hypothesis generation is recognizing that all hypotheses about functional affordances and symbolic expressions are exactly that—hypotheses, which must be subjected to empirical evaluation. Fortunately, new analytic methods and tools have been developed for situations—like IT effects studies—that exhibit causal complexity, such as multiple causation and equifinality (many causal paths). Analytic strategies based in Boolean algebra and fuzzy set logic have great potential to surface holistic patterns from numerous potentially causal features (George and Bennett, 2005; Ragin, 1987; Ragin, 2000).

Although our emphasis in this paper has been on what about IT artifacts makes them useful to, and interpretable by, users, the concepts of functional affordances and symbolic expressions are most useful when researchers also carefully analyze users' capabilities and goals. In this way, the concepts of functional affordances and symbolic expressions can shed light on the processes by which users appropriate and interpret information technology. How to analyze users' goals and capabilities in relation to IT artifacts represents an important direction for further development of the concepts discussed in this paper.

6. Conclusion

DeSanctis and Poole made an important contribution to the study of IT uses and effects with their insightful concepts of structural features and spirit. Unlike their concept of appropriation, which has found broad acceptance in the IS community, the concepts of structural features and spirit have not been widely used. Whatever the reasons for their neglect, we believe that concepts like structural features and spirit are essential for the information systems research enterprise, particularly IS design science. In this paper, we tried to address concerns about DeSanctis and Poole's concepts by redefining them as technical objects, functional affordances, and symbolic expressions, and by discussing how IS researchers might use these redefined concepts in IT effects studies. We hope our extension of DeSanctis and Poole's concepts has made them more functional for other IT effects researchers while retaining much of their original spirit.

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