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Towards an Informativity Account of Design Research

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In this paper we apply a sociomaterial perspective to the relationships of people, work, and technology to provide further insights into design research. We focus attention on the phenomena, not the artifact, produced through processes of 'informativity.' This approach challenges the Cartesian dualism upon which design is premised and reveals the emergence of multiple enactments of information and technology by people across time and context. Informativity accounts for the variable processes of information discovery, selection, and support and acts as a source of potential creativity, improvisation, and design.

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Introduction

The implications of sociomateriality for design research have been little discussed. The analytic language for design research is still one of Cartesian separation with the division resting between a specific artifact and the human or organizational user. But the sociomaterial perspective is one of *mangling* or *entanglement* of information technology and work in organizational contexts such that to discuss each as separate components presents a false dualism. In reaction to a perceived over-emphasis on social construction of work and of technology in the research discourse, recent organizational research has sought to illuminate the question of "when and how does materiality come to matter?" The focus on the co-constitutive nature of the discursive and the material has garnered an increasing amount of research attention.

Sociomaterial research in IS has predominantly focused on the implementation, use, and impact information technologies. In this paper we examine how a sociomaterial lens can inform Design Science Research (DSR) (Hevner et al., 2004) to better understand the design

of sociomaterial assemblages. DSR argues that knowledge can be created through the design, building, and testing of information technology artifacts. However, DSR has not confronted the questions raised in the sociomaterial perspective as the DSR emphasis has been almost entirely on design of the artifact, informed by behavioral theories but independent of the people or the social contexts in which they are used (Hevner et al., 2004). The emphasis on artifacts raises questions about both their *informative* and *material qualities*. Although artifacts are commonly considered to include "constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems)" (Hevner et al., 2004 p 77), there is a published perception that the artifact *and the information they provide* are material and deterministic (Leonardi and Barley 2008). The artifact focus assumes an underlying metaphysics of *representationalism* (Barad, 2003; Kallinikos, 1995) in which there is tripartite arrangement between a representation, the distinct referent to which it refers, and an independent knower to whom the referent has meaning (Barad 2003).

In this paper we argue that DSR has become constrained by the language of material representations in the form of artifacts which are provided to us in the world. Like virtual galleries in which "presentation of the painting as practically substitutable for the real experience" (Higgs et al., 2000 p 10) the representations embedded in information systems are considered as rational for acting in the world and sometime are considered sufficient replacements for the world (Borgmann, 1999). The common language and metaphors in design acts as a proxy to represent the world around us from a material perspective in which artifacts are considered as causal interventions in a person's life or in organizational life that produce social and material outcomes (Gregor and Hovorka, 2011). This creates a functionalist, predetermined view of the world in which a designer seeks to elicit a representation of the problem space and provide an artifactual solution. There is no

emergence, only specification, as if the design, building, implementation and adoption of the artifact alone are sufficient. This perspective obscures the critical intentions for the creation and use of information systems – *to inform*. It is important in begin to theorize design as creation of *informative* worlds of humans, technologies, and information in which we, as people, chose to move seamlessly through multiple changing sociomaterial situations.

We broaden DSR by using a sociomaterial perspective to pursue design as creation of phenomenon resulting from the 'mangling' or 'entangling' (Orlikowski and Scott, 2008; Pickering, 1993) of action, reflection, practice, technology, and information. We challenge the artifact focus of DSR and posit *informativity* (the performativity of information) as a primary effort of design science to draw "attention to how relations and boundaries between humans and technologies are not pre-given or fixed, but enacted in practice" (Orlikowski et al., 2008 p 462). We challenge the traditional Cartesian distinction between designed *objects* and object *designers* as conceptually and physically separate. We base the argument on the recognition that design rarely starts from an empty state and that significant design activities result from secondary design (Germonprez et al., 2007; Germonprez et al., 2011) which includes improvisation (Ciborra, 1999; Ciborra, 2002), end user design (Ko et al., 2011), and lead user design (von Hipple, 2005). The design and evaluation of what we have come to term 'an artifact' intended to solve a particular problem is not a fixed and predetermined process. Rather multiple configurations of social and technical situations emerge from the day-to-day discourses we construct with information about, for, and as reality (Borgmann, 1999) and the characteristics of the enactment are idiosyncratic across time. An *informativity* perspective on design expands DSR from an exclusive creation of an artifact to the design and evaluation of an entanglement of technology and people guided by changing sociomaterial situations in which we, as people, transition between them as seamlessly as birds become fish in an MC Escher drawing (Figure 1). Difficulties may arise when people

lose track of context, meaning, function, or evaluation (e.g. mode confusion, navigation, sail norms) as they transition through their daily information lifeworld.

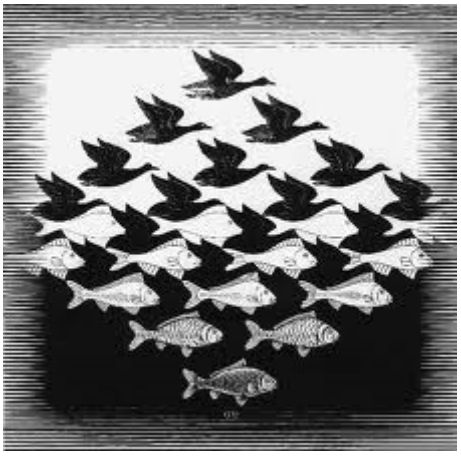

Figure 1: Metaphorical transitions between Sociomaterial Enactments

Design then is about the creation of assemblages from which multiple desired phenomena emerge. DSR has a role in identifying and relieving the tensions between the constraints and the possibilities which emerge from the material and social entanglement as people transition through contexts, times, and places in their daily, informative activities. These local determinations of discursive versus material constraints and possibilities are the *intra-actions* among components which can be enacted differentially. The intra-actions of material and social in design research reveal a range of phenomena, representations, and implications for evaluation. This in turn informs an *informativity* perspective in design.

A sociomaterial view additionally informs the production of scientific knowledge in design research. This line of inquiry questions the epistemological assumptions underlying *knowledge production* in the sciences of the artificial (Gregor, 2009; Lee, 2010; Simon, 1996). As DSR is constituted to increase scientific knowledge through building artifacts, it is critical to realize the *performative* processes of information which underlie science and are

specific to design science approaches. Because the language and assumptions of separation "lead conceptually and methodologically to a realm of possible findings that are pre-configured" (Orlikowski et al., 2008 p 463), a performative perspective of information shifts the focus to entanglements which produce phenomena rather than focusing on the design of the material artifacts. We describe the sociomaterial approach to extract the key precepts of the *performativity* of information as applied to information systems. Following Barad's (2003) analogy to diffraction gratings, we suggest that viewing DSR through an *informativity* perspective (performativity of information) displays "shadows in "light" regions and bright spots in "dark" regions (p 803) such that we extend DSR.

A Sociomaterial Perspective in Design Research

The rapid expansion of information systems throughout organizations and within everyday life has produced an increasing volume of research covering multiple phenomena centered on information systems. This research includes but is not limited to: development methods, technology adoption, engagement by individuals and groups, appropriation, implementation, organizational impacts, and societal impacts. In most cases, technology was researched as an independent variable having a range of determinant effects on outcomes on organizations, groups, or individuals. The progression of explanations for the use and consequences of information technology has swung from a stance of technological determinism (Leonardi and Barley, 2008) to one in which "every engagement with a technology is temporally and contextually provisional, and thus there is, in every use, always the possibility of a different structure being enacted" (Orlikowski, 2000 p 412). Volutaristic or constructivists accounts have come to play an important role in organizational technology studies "where the

constitutive powers of language are emphasized and 'natural' objects are viewed as discursively produced" (Mitev and Howcroft, 2004 p 293).

As with other scientific endeavors, IS researchers become stuck in patterns of dominant thought and tend to "tilt" toward privileging one side or the other in the social-material debate (Leonardi et al., 2008). These sets of opposing ideas, or antimonies, "define dilemmas that are ontologically difficult, if not impossible, to resolve (Leonardi and Barley, 2010 p 2). As the pendulum swings between deterministic and voluntaristic or between material and social there is little in the way of synthesis or transcendence of ideas. Instead, we have adopted methodologies accepting of multi-paradigm and multi-method approaches which encourage entrenchment of Cartesian dualism and concomitant but separate analysis of material and social phenomena (Davison and Martinsons, 2011).

Contemporary research acknowledges the interaction and interdependencies of technologies and social structures and that IS phenomena exist in the interstices between the discursive and the material. But *interaction* infers a separation between components which preexists their relations. Barad's (Barad, 1996; Barad, 1998) interpretation of Bohr's physics questions both the ontology and epistemology of a priori entities and seeks to resolve the tension between social construction and material realism. Efforts to transcend this dualism in organizational research tend to view IT an as a sociomaterial assemblage in which "our analytical gaze is drawn away from discrete entities of people and technology, or ensembles 'of equipment, techniques, applications, and people' (Orlikowski & Iacono, 2001) to composite and shifting assemblages" (Orlikowski et al., 2008 p 455). But for the most part, subsuming Cartesian subject/object assumptions is quite difficult. Our technological culture, our language and our metaphors all reinforce the tools, problems and solutions as distinct and separate from 'us' as individuals.

The blurring of the distinctions from a sociomaterial perspective is not new. Heigegger's (1962) focus on the emergence of "being" and how apparatus are formed (Riemer, 2011), and Latour's Actor Network Theory (2005) are closely related to a sociomaterial perspective. Broadly, what these approaches have in common is the notion that the world-as-encountered is constituted from both socially constructed (discursive) and material aspects which co-constitute each other. To emphasize preexisting discursive/material distinctions or to privilege one over the other obscures the richness of the world which people and technologies co-create. Technology becomes noticeable as a material object, no longer an embedded part of someone's lifeworld when it becomes a constraint through a disruptive breakdown. This disruption can be interpreted as an 'agential cut' which moves the technology from ready-at-hand to present-at hand, therefore becoming noticeable to a person in their world of being. The properties of the entity have changed vis-à-vis the context. As an example, Wikipedia participants shift between engaging with the technical system to enhance discursive practice, engaging as a member of the community where the technology is irrelevant, and becoming informed by the output of the collective output of the community as it changes information over time (Germonprez et al., 2011). These different modes of being reconstitute the social-material relations depending on context.

The key aspect of this perspective is the ontological claim that the discursive and the material do not have inherent *a priori* properties. This does not deny that there distinctions can be made between the discursive and the material; rather the distinction is temporally and contextually variable and is represented by local determinations (agential cuts) that are emergent, fluid and ephemeral. We believe that DSR has largely focused on IT as an independent variable and has ground to make up regarding how to account for designing for a world rich with unique people and practices who shift between multiple practices (work vs. personal), modes of being informed (passive recipient vs. active inquiry), and technological

platforms. The inclusion of a sociomaterial view in DSR is more than simply suggesting that researchers pay lip service to the complexities that people and practices bring to the table. There are substantive design questions surrounding the performativity of information in that varying social and technical constraints influence the decision making and communications people engage in. Thus, we offer *informativity* as an approach to ground DSR in a sociomaterial stance towards design, a stance that stems from the performativity of informing.

Extracting *Informativity* in a Sociomaterial Perspective

The view of sociomaterial assemblages in organizational research has the effect of turning the research spotlight on the materiality of everyday life. We are challenged to imagine engaging in any practice without linking the material with the social. The ontological claim is that the social world and the material world co-constitute each other and exists only in relation to each other. This relational ontology presumes that the social and material are inherently entangled such that we cannot presume "independent or even interdependent entities with distinct and inherent characteristics... Any distinction of humans and technologies is analytical only, and done with the recognition that these entities necessarily entail each other in practice" (Orlikowski et al., 2008 p 456). This admits to the analytic capability for making *agential cuts* which effect a local distinction within phenomena distinguishing subject from object (Barad, 2003). An agential cut is a specific material and discursive configuration which enacts a local and temporary separation between subject and object consistent with a phenomenological sense of social-material separation. Agential cuts therefore support multiple *changing distinctions* rather than inherent *discursive-material distinctions*.

How we consider the changing distinctions of people challenges the representational assumptions of DSR and refuses the representational separation between "words" and "things" advocating "specific exclusionary practices embodied as specific material configurations of the world (i.e., discursive practices/(con)figurations rather than "words") and specific material phenomena (i.e., relations rather than "things") (Barad, 2003 p 814). The emphasis of inquiry becomes the phenomena which result from intra-actions in which boundaries and properties of phenomena become determinate through a local resolution and that particular set of subject-object distinctions become meaningful. For example, the imaging through a scanning tunneling microscope (STM) is not a simple matter of plugging the device in and turning it on. Instead creating an STM image is a complex intra-action of tunneling theory, the material to be imaged and its preparation, the STM artifact and the practices of its operation, and the interpretation of the results (Barad, 2007). To examine the "impact" of the STM on science is to ignore the performativity of the entire assemblage and ignore the emergence of the image as a result of all the discursive and material parts together. Analogically, the theoretical concept of *IS success* is not a conceptual construct that can be theorized by observing, but is determined as a result of the entanglement of human and non-human agents. Each of the items in the construct reflects social value judgments which, if selected differently, would produce different analytic outcomes. The technologies and the settings to which the construct is applied require that the technology become entangled in changing contexts.

Orlikowski's (2007) exposition on the distinctions of the Google search engine emphasizes that the performance and results of a Google search are geographically and temporally emergent. In DSR the emphasis would be on the artifact whose *use* will produce a fixed and finite answer. The answer itself can be measured in terms of success, revolving around the materiality of the ranking algorithm and the technological 'search engine.' But separation of

the material artifact from the *informing* activity is a matter of making a cut between entangled components. A Google search is embedded in the lifeworld of people as is not simply a 'tool' to do 'something.' The discursive intention to be informed by a *digital search for information* is not separate from using algorithms to look at material databases. The material impact of the search – the information which will influence decisions, research or attitudes, is best considered as the designed *informativity* of the system. This extends design research beyond the immediate success of the search, and accounts for the authenticity of people, their context, and their future.

Remarkably, for a discipline named for 'information,' information has been little discussed in the IS field (Yoos 2010, Buckland 1991) with most of the current expositions existing in linguistics, communication, and philosophy (Borgmann 1999). We posit that informativity includes the *information* and the creation of reality (Borgmann, 1999) resulting from the emergence of relationships among information, people, and technologies (e.g. the previous digital search example). If information is viewed as solely affected as a material 'thing' to be collected, transported, stored, and distributed, it becomes deterministic and the recipient becomes passive observer. If, on the other hand, information is only considered to be idiosyncratically constructed and interpreted through language and symbols, we lose common ground for symbolic communication and common understanding. Informativity recognizes that the materiality and the reality of information is the result of localized emergence of relationships enacted by the person. As such, information, and what it represents can be material and/or discursive depending on the specific context. Since Google page ranks are temporally dynamic and geographically constrained, a spatial-temporal relativism of search results which has the ability to differentially shape decision making and research practice as a function of time and location. It is this recognition of the emergent creation of materiality which can inform design science. Examples include clarification of modes of operation to

reduce mode confusion (Bredereke and Lankenau, 2002), information quality and confidence metrics, and the provision of semantically related information such as that once provided in Google's Wheel of Wonder.

In the informativity of information systems, there exists no prior independence or separation of the materiality of the technology and the social actors between which an interaction could occur. Rather, the performance of the search is the result of "computer code that was produced and is maintained by software engineers, that executes on computers (configured with particular hardware and software elements), and whose operation depends on the millions of people who create and update web pages every day, and the millions of people who enter particular search terms into it" (Orlikowski, 2007 p 1440). This has been termed 'a mangling of human and material agencies' (Pickering, 1993) and 'a creative sociomaterial assemblage' (Suchman, 2007). An informativity perspective challenges the Cartesian distinction which underlies much IS research as the *information* is a black box which is assumed to be collected, stored, analyzed, distributed, or presented by the designed artifact. The informativity perspective raises the important question of correspondence between the social (discursive) and the material (artifactual), and the role of agency (Barad, 2007) which can be brought to bear in the realm of design consideration. Additionally, informativity cuts to the heart of the limitation of the representations embodied by information and information technologies.

Materiality

One of the challenges of sociomateriality to design science lies in the concept of *materiality*. Information technologies are often assumed to have inherent materiality – the computer hardware, the physical network, even the written code which performs computations. Hevner et al. (2004) refer to information technologies "as database management systems, high-level languages, personal computers, software components, intelligent agents, object technology,

the Internet, and the World Wide Web" (p. 81) but does not explicitly define what an information technology is or its material nature. In their review of top management studies, Orlikowski and Scott (2008) note that 95% of organizational literature surveyed does not consider information technology as having a role in organizational life. They further suggest that defining information technology is inherently problematic as it may refer to material objects, process systems, methods, and techniques, a sentiment echoed in DSR as processes, models, representations, and algorithms that take the form of language and social constructions. Leonardi and Barley (2008) state that "authors of research on information technology remind readers that despite their materiality, technologies are products of negotiations…human agency… and personal interest" suggesting a general perception that artifacts are material.

To overcome the complexity of materiality, information technology, and artifacts one approach would be to study identifiable systems such as Enterprise Resource Planning Systems, Group Support Systems or email systems, suggesting that each entails materiality, IT, and an artifactual nature. But this approach is insufficient for design science which includes software, algorithms, and processes as artifactual entities. Equally problematic is the tendency to equate materiality with determinism, a misstep alluded to earlier that does not account for the contextual behavior of people and their evolving lifeworlds. So how should we consider the complexities posed by these seemingly related but obviously independent terms of materiality, IT, and artifact?

A resonant theme in research establishes that "material properties are construed as features that provide opportunities for, or constraints on, action" (Leonardi et al., 2008 p 162). Thus materiality implies inherent technology properties and artifactual affordances. Considering materiality in this light reveals the multiple configurations of information systems, information and artifacts through the activities of a person across time and context. In some

instances, such as a digital search, a person does not separate the technology from the behavior (e.g. “I Googled it”) and the technology remains a discursive extension of behavior. At other time, such as a breakdown where the technology becomes noticeable, the materiality of the tool impedes the activity and the very same technology briefly materializes as a constraint. This illuminates the importance of materiality as people enact information through technologies and processes. By considering how materiality may emerge in different contexts and times, and how it may constrain action (Kallinikos, 2004) or may provide opportunities (Introna and Whittaker, 2002) or create improvisation (Ciborra, 1999), design science will be better able to design for, and theorize about, the types of information systems which people ‘invite along’ and differentially enacted as they seek the materiality of information and communication.

Representation

The dominant perspective in design science is based on an inscribed subject-object dualism that promotes an instrumentalist and utilitarian orientation towards mastery of the world (Kallinikos, 1995). The problem-solving strategy is based on the idea that “solving a problem simply means *representing* it so as to make the solution transparent” (Simon, 1996 p 132 emphasis added). Simplifying complexities of the world and reducing problems to fundamental components is further carried into the design of IT artifacts which “must accurately *represent* the business and technology environments used in the research, information systems themselves being models of the business” (Hevner et al., 2004 p 87 emphasis added). *Representation* becomes a selective objectification of things, states of things, and processes through a reductive abstraction of the totality. It is not a proportional scaling down of the environment and the problem space but a rendering which is both selective and discriminatory (Kallinikos, 1995). Through selection and abstraction, designers identify a subset of the goals, relevant functions, necessary processes, and degree of

predictable mastery over the bounded problem space. The representation is crucial as artifact design is intended to reconstruct a material world that does not yet exist. This entails a "relentless analytic reduction of the composite character and complexion of the world. Reality is meticulously dissolved and regained after a long analytic retreat and technological reconstruction" (Kallinikos, 2009 abstract). Thus design research assumes a representational view in two ways. First the abstraction and simplification of the problems space and the appropriate means, ends, and laws is founded on an objectification of the social and natural world such that they are amenable to codification, ordering and intelligibility through material and cognitive techniques. Second, the artifact itself is a representation of the organizational environment and problem space.

Discussion

To illustrate how sociomateriality can be used to inform design science, we return to *informativity.* Recalling that informativity is the creation of reality (Borgmann, 1999) resulting from the emergence of people performing information activities. Informativity is the material affectation as people collect, transport, store, and distribute information in the ongoing movements and changes in their lifeworld. The following two examples illustrate how informativity can inform design research by incorporating a larger sociomaterial view. The first example illustrates informativity in a case of secondary design of Wikipedia pages (Germonprez et al., 2011). The second example illustrates informativity at an organizational level and how it can be applied to understand design of the Linux kernel (Fitzgerald, 2006).

Germonprez et al. (2011) illustrates a case of secondary design demonstrating how people engaged in active and reflective practices in the ongoing evolution of Wikipedia information. The case illustrated that the focus on Wikipedia as a technology is almost irrelevant and that

the phenomenon is the emergence of information, processes, discursive conventions, and material edits histories through and ongoing performance. This process defines Wikipedia as an artifact; but more importantly, the process defines how information becomes reified through an emergent and arching trajectory of participant engagement. The case illustrates that the design process is one of variation discovery (opposing views), variation selection (reified content), and variation support (metaphorical and citation reference). Wikipedia, as an organization, provides a 'base-artifact' from which people endue the materiality of the system. In this type of case, systems are not designed-in-full where a single designer not only provides the functional structure but also the information. Such an approach is not one of informativity as people would not be engaged participants in the creation of system value. With many systems there is no singular primary design that starts from zero to build 'an artifact.' Rather people and technologies intra-act in the emergence of man evolving and improvisational system. Informativity thus can shed light on how such systems are designed, and how such systems are represented, and how they provide representations to inform.

As a second example of informativity in design, we turn to the development of the Linux kernel (Fitzgerald, 2006). The design of the Linux kernel is increasingly dominated by organizational participation in the community, accounting for over 75% of all code contributions. In response, organizational participation in the Linux open community has become one of maintaining strong citizenship within the community while still being able to leverage the community for organizational gain. Linux kernel design becomes a balance of organizational activities, property, and culture against the community level improvement of the kernel itself. Organizations must recognize a design process that allows for the management of tensions between normative expectations of any organization and the overall context of the Linux kernel. By doing so, organizations can capture and engage design

through the creativity of participating organizations and the emergent nature of information design embedded in the Linux kernel.

The hegemony of the artifact in design research has assumed a specific Cartesian relation between the material technology artifact and discursive social constructivism (e.g. language, problem space formulation problems of evaluation) as a foundation for design activities. The ontological separation between the social and the material is inherent and fixed. In arguing that the design of information systems is the production of phenomena, rather than material artifacts, we shift the focus to the entanglement of the discursive and material such that local intra-actions (as opposed to an interaction between pre-existing elements) create a range of phenomena through which people navigate seamlessly. *Informativity* reveals an essential conundrum of design: when designing from an instrumental, functionalist perspective, the designer assumes that all contexts and users fall within a known problem space and that neither the context nor the users will change significantly over time. Even though it is well understood that the role of information systems in organizing arises at the intersection of the material and the social, the design process privileges the artifactual such that "as 'material agents,' technologies can constrain social action in a manner similar to that of social structures" (Boudreau and Robey, 2005 p 4). By recognizing the manner in which information systems become materialized, are alternatively are enacted as discursive elements, research is better equipped to design and theorize about the transitions between modes of information which people engage with daily. It is important to note that this materiality extends to the informing of communication activity that is the ultimate purpose in engaging with an information technology.

An informativity perspective on design science recognizes and reflects on the degree to which the designed system enacts agency versus the degree to which the human enacts agency. The foundations of DSR rest on design activities and on evaluation activities which

contribute to design knowledge. The process of design requires agential cuts such that the designer distinguishes him/herself from the object being designed. But as we have presented in our discussion of specific enactments, the agential cuts made in regard to the separation between the material technology and the user, background and context of the system are a matter of choice and will influence both the informativity of the entanglement and the manner and outcome of its evaluation.

Implication of *Informativity* for design science

In first addressing design activities we must recognize that there is a continuum of systems which vary in the degrees of secondary design admitted by the entanglement at the individual, group or organizational level. Some large scale technological systems are enacted as reinforcing an artifact-person distinction which seek to enforce a rational sequences of functions and tasks (Kallinikos, 2002). The technology itself may limit information inputs or outputs which are considered as irrefutable sources of 'truth.' Other systems may be constrained by technological or institutional dependences which limit access or social use (e.g. use of social networking applications in work environments), or as in the case of Internet disruption in Egypt, they may become politicized and subject to new constraining agential cuts. Yet other entanglements may be designed which invite or even require improvisation, malleability, and reconfiguration (Germonprez et al 2011). Secondary design (Germonprez et al., 2007; Germonprez et al., 2011) is one theoretical approach to recognition of the configuration of material and discursive which can emerge from the entanglement of people, technology and information.

This perspective posits that the designer must forgo attempts at prediction and recognize that the entanglement will unfold in unpredictable ways during on ongoing process of user initiate redesign with different structures, roles, functions and meanings emerging with every

engagement. As noted by (Ciborra, 1999 p 149), “if one looks carefully at the variety of IT applications being developed and in use in a few R&D labs, one can find many already functioning systems able to support decision-making and conceived as improvised processes. The theme of improvisation can help establish a common framework among what at present may seem scattered experiments or peculiar applications.” But if system use and organizational change are thought of as improvisation (Orlikowski and Hofman, 1997), the initial design phase must incorporate features which admit and invite human agency and evolution. Although such design would seem beneficial from the perspective of agility and flexibility, it does create a potential risk of temporal and geographic dependency of information. When information services can be recombined and information repurposed and recombined, our confidence in the information may be decreased.

In addition, the domain of phenomenon which DSR must address is expanding. Any organizational context is a collection of personal and group activities; people must manage the tensions between normative expectations of what they want to accomplish and the local context what the organization expects them to do. Increasingly, information and information systems must span both. Technological controls and social norms can be materialized as constraints but enacted differentially according to time and place. As a person transitions through information, technology and contexts, allowable activities are frequently not clearly defined either materially or discursively. Design must therefore address phenomenon such as mode confusion (Bredereke et al., 2002) and improvisation as people engage with changing spatio-temporal enactments of technology and information created by the person. In light of informativity, DS research enfolds the trajectory of sociomaterial entanglements as a process of variation discovery, variation selection, and variation support. The primary phase of design should accommodate and support the *in situ* design trajectory as improvisation (Ciborra, 1999; Germonprez et al., 2011) which increases variation and provides a source of creativity.

If design produces systems that restrain the normative expectations of people we reduce improvisation and materially constrain innovation.

Therefore DSR can expand to incorporate multiple levels of design: from hardware and software platforms, through interaction, sensorial and transitional design to information and symbol design. Without attending to information design issues (e.g. the 'below-the-fold' phenomenon, adequacy of representations of information complexity, sense making), technological artifacts will be enacted in less informative agential cuts. This is particularly salient in the increasingly complex world of devices and modes of use which people switch between rapidly every day in professional and personal capacities. The way in which the entanglement of technology, people and information is designed will affect the informativity of the engagement.

In addressing the evaluative aspect of DSR, an informativity account requires that we acknowledge that the phenomenon we are studying is the result of the very measurement system we are using to determine the outcome. One of the central claims of DSR is that knowledge can be gained through the process of building artifacts. But the performativity stance challenges the separation of the measurement process from the phenomenon being measured. Barad (1998) offers the example of the measuring the properties of light. By selecting one apparatus which enables the detection of particles, light is shown to act as particles. But selection of another apparatus demonstrates that light acts as a wave. But based on research in physics, Barad (1998) argues that every measurement is based on the selection of particular observations, measurement tools, discursive variable definitions, and variable exclusions and that "no inherent distinction preexists the measurement process,…. thereby embodying a particular constructed cut delineating the "object" from the "agencies of observation." This particular constructed cut resolves the ambiguities only for a given

context; it marks off and is part of a particular instance of the phenomenon" (Barad, 1998 p 421).

The selection and definition of evaluation are also subject to conditions of informativity. For example, the concept of *accuracy*, when defined for conventional explosive versus low yield nuclear missiles results in different definitions based on the entanglement of the material effects and the goal state in the specific context (Hacking, 1999). To disable/destroy an armoured vehicle with conventional explosive requires an accuracy of a few meters. But in a densely inhabited area, accuracy of low yield nuclear missiles is defined by the radius of significant collateral damage. Thus the way accuracy is discursively defined changes the material design which in turn, determines the outcome of the measurement.

In the design science research space the process of evaluation of design often shifts the phenomena to a rational, economic value base. The design requirements are defined by what we discursively elicit as the problem space and create a technologically-based solution to the problem. But the evaluation of the social and material outcome occurs within the context in which the artifact is socially entangled as if we were neutral observers. Although we can determine whether the intervention was successful in relation to the selected referents, our ability to increase fundamental knowledge is constrained by "the fact that the basic nature of the universe is not something that is given and fixed in advance, but rather something that emerges from the intra-actions of the experimental situation and the entanglement of apparatus and phenomenon (and beyond) that constitute the measurement: "the nature of the observed phenomenon changes with corresponding changes in the apparatus," requiring us to reject "the epistemological assumption that experiments reveal the pre-existing determinate nature of the entity being measured" (Barad 2007 p 106). For example, some success measures are used by the organization as performance indicators to change the processes which are being evaluated. By measuring the construct using a technology designed to

produce the effect, we risk an essentially tautological result. This radical epistemological shift raises significant questions regarding the types of knowledge DSR, and IS in general can obtain through current methods. Although this may be easy to dismiss if IS is viewed solely as an applied science, serious consideration of this point is warranted is DSR seeks to develop more fundamental knowledge claims.

These initial steps toward examining DSR through the lens of informativity suggest interesting concepts for research. Design of informative assemblages which support variation and creativity, and capture the process of improvisation would be beneficial in many contexts. Questions regarding the limits of information to represent reality or replace reality versus contexts in which 'the real thing' is necessary for the goal will help bound the limits of information system implementations. An informativity account of design begins to approach design as a question of "what is the discourse we want to have with the world?"

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