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PEER-REVIEWED JOURNAL ON THE INTERNET

Digital materiality? How artifacts without matter, matter

by Paul M. Leonardi

Abstract

It sounds rather odd to say that digital artifacts — like software — have material properties because people generally think of materials or materiality as physical substances such as wood, steel, and stone. Yet scholars increasingly talk about the "materiality" of digital artifacts. What do they mean? In this paper, I explore two definitions of the adjective "material" — practical instantiation and significance — in addition to its normal connotation as matter. I argue that treating materiality as the practical instantiation of theoretical ideas (like policies that allow women to vote help make material the idea that sexes are equal) or as what is significant in the explanation of a given context (like material evidence in a courtroom trial) provides a more useful framework for understanding how digital artifacts affect the process of organizing. I contend that moving away from linking materiality to notions of physical substance or matter may help scholars of technology integrate their work more centrally with studies of discourse, routine, institutions and other phenomena that lie at the core of organization theory, specifically, and social theory more broadly.

Contents

If someone asked you to point your finger at an organization, at what would you point? Would you point at a person? A group of people? What about the sign reading "XYZ Corporation" carefully placed on the lawn in front of an office building? How about the office building? Would you point your finger at desks? Computers? Conveyor belts? You might answer that no one thing alone is an organization and you would argue instead, as theorists have been doing recently (Fayard and Weeks, 2007; Orlikowski and Scott, 2008; Pentland and Feldman, 2007), that organizations are made up of people doing work with material artifacts. Following such a definition you'd likely point to both people and the technologies (both of which might be broadly called "artifacts") they use to do their jobs.

Despite the fact that artifacts occupy a central role in the process of organizing, organizational theorists have spent the last few decades managing to carefully avoid pointing their fingers at them. Beginning with the importation of micro–sociological concepts such as the performance (Goffman, 1961), the contract (Garfinkel, 1967) the negotiation (Strauss, 1978) the practice (Bourdieu, 1977) and structuration (Giddens, 1979) into the field of organization studies in the 1970s and 1980s, organizational researchers have increasingly pointed their fingers at the space between things. Drawing on these influences, authors such as Van Maanen (1975), Weick (1979), Smircich (1983)

and Barley (1986) began to advocate an approach that treated organizing as a process created, perpetuated, and changed by patterns of interaction between people. The decidedly agentic perspective that accompanied this approach has focused many researchers' attention on how those patterns of interaction catalyze networks, crystallize into routines, and concretize as institutions.

Although procedural views of organizing successfully highlight the importance of human interaction in organizational dynamics, they often refrain from looking at those artifacts around which such interaction occurs. As Orlikowski [1] notes: "A quick perusal of much organization literature reveals the absence of any considered treatment or theorizing of the material artifacts, bodies, arrangements, and infrastructures through which practices are performed." Orlikowski and others (Schatzki, 2005; Suchman, 2007) have thus called for more theorizing about the artifacts people use in organizations, suggesting that the *materiality* of those artifacts is consequential for our understanding of the organizing process. This notion of materiality seems to separate the physicality of artifacts like bodies, chairs, staplers, filing cabinets and drill presses from the more conceptual nature of discourses, routines, and institutions. While some authors argue that the boundaries between the physical and the conceptual are not fixed but rather constantly negotiated in practice (Latour, 2005; Orlikowski and Scott, 2008; Suchman, 2007), they usually submit, without protest, to the idea that the physical and the conceptual are phenomena of different orders. The physical (obviously) can be touched while the conceptual cannot. Physical things are made up of materials like flesh, bone, wood, glass, steel, and plastic — each one with its own matter. These material properties offer certain opportunities and constraints that simply cannot be overcome — you cannot see through wood or light glass on fire. Although the content of an institution or the contours of a routine may seem as difficult to change as the arrangement of polymers in a plastic, the conceptual offers a particular freedom of improvisation and re–creation that the physical does not — simply because it lacks matter.

Were there only physical artifacts and conceptual innovations it would be relatively simple to define materiality as physical matter and to specify how the properties of those artifacts enable and constrain people's actions in ways that are distinct from how people act in response to norms and rituals. Today, organizing is frequently accomplished with the aid of software–based digital artifacts. A digital technology like a word processing program or a finite element solver is an artifact that is not comprised of matter and cannot be touched or, in the case that it runs in the background on one's computer, even pointed to. Although it has no physical properties, software clearly does not exist in the conceptual domain because it provides hard constraints and affordances in much the same way as physical artifacts do. Indeed, many researchers suggest that software, intangible though it may be, can be described in terms of its materiality (Hutchby, 2001; Jackson, 1996; Leonardi, 2007; Orlikowski, 2007; Suchman, 2000; Volkoff, *et al.*, 2007). Yet as digital artifacts, software–based information technologies are not built of materials, *per se*. Thus, as Leonardi and Barley [2] note: "because most information technologies are software rather than solid physical objects, it may seem odd to say that information technologies have 'material properties'."

In this paper, I pose the question "Can digital artifacts have materiality?" In exploring an answer, I consider three definitions of materiality taken from the *Oxford English Dictionary*: Materiality as (1) matter; (2) practical instantiation; and, (3) significance. I argue that if materiality is defined simply as matter, that digital artifacts cannot be said to have materiality. However, when materiality is understood to represent the practical instantiation and the significance of an artifact, digital artifacts can clearly be seen to have materiality. In summary, I argue for using these two alternative definitions as lenses through which to understand the influence of "digital materiality" in the organizing process. I also suggest that using these alternate definitions can help researchers to integrate studies of digital artifacts with other types of intangible phenomena, such as routines and discourse, which are at the core of most all theories of the organizing process.

What is “materiality?”

In recent years, the term “materiality” has been cropping up in the works of authors in management, communication studies, and sociology, to name a few places. But what does this word mean. Let’s begin by taking a look at how it is used in context across a number of fields.

In the field of management, Orlikowski [3] has begun to make the argument that even though organizations are saturated with new digital artifacts, research “largely disregards, downplays, or takes for granted the materiality of organizations.” Although she does not explicitly define “materiality” in her paper, she makes the following association:

> “Consider any organizational practice, and then consider what role, if any, materiality may play in it. It should be quickly evident that a considerable amount of materiality is entailed in every aspect of organizing, from the visible forms — such as bodies, clothes, rooms, desks, chairs, tables, buildings, vehicles, phones, computers, books, documents, pens, and utensils — to the less visible flows — such as data and voice networks, water and sewage infrastructures, electricity, and air systems.” [4]

Broadly, Orlikowski seems to define materiality as “stuff.” I say “stuff” because a definition of materiality as “object” would imply tangibility — tactile experience. To be sure, one need only open up any dictionary and look for the entry “object” to find a long list of items that can be touched. In Orlikowski’s definition, examples of clothes, tables, and books represent “tangible stuff”; they can be touched and are constructed of physical materials (they are “objects”). But data and electricity are not objects. They are “stuff” without a tangible character. You can’t touch data. You can touch the paper (an object) upon which data is written; you can touch the screen (an object) upon which data is displayed; but you can’t touch the data itself. Other “stuff” like voice networks are certainly comprised of both tangible and intangible “stuff.” You can touch the copper wires or fiber–optic cables over which voice is transmitted; you can touch the routers and switches through which the direction of voice is channeled, but you can’t touch the data packets in which the sounds of voice are encoded. For Orlikowski, tangibility — and thus matter — is clearly not a necessary component of the definition of materiality. Indeed, the empirical case that Orlikowski offers in her paper focuses on people’s “everyday engagement with the materiality of the Google search engine.” [5]

Ashcraft, *et al.* (2009) argue that the field of communication’s turn towards constitutive models of communication (models based on the premise that communication generates, as opposed to simply transmits, reality) has skewed researchers’ attention to the symbolic as opposed to the material. They argue that communication theorists must be “accountable to the materiality of organizing,” which they define as “objects, sites, and bodies” if they are to maintain relevance and theoretical and practical import [6]. At first glance, materiality seems to imply tangibility. You can touch objects, that exist within specific sites like desks, chairs, walls, computer monitors, etc. and you can touch bodies. Yet later the authors argue that “materiality entails ‘brute facts’ and ‘institutional facts’” [7] and they draw on the work of communication researchers like Fulk and colleagues (Fulk, *et al.*, 1996) who studied networked database software applications, Poole and DeSanctis (DeSanctis and Poole, 1994; Poole and DeSanctis, 1992) who studied group–decision support software, and Rice and Danowski (1983) who studied voice messaging software along with communication researchers. Whereas objects, sites, and bodies, make it easy to define materiality as having some tangible character, software does not.

Trevor Pinch [8] argues that traditional sociological studies “carve up the world … such that sociologists deal only with social things. The world of objects, machines, and materials are left unanalyzed or considered the territory of others, perhaps scientists and engineers.” Pinch asserts that

sociology has not dealt with materiality, which he defines as “the world of objects and things” [9] and he provides numerous accounts drawn from sociological studies of how technologies are treated purely as symbolic as opposed to “material.” He suggests that some sociologists who have realized this lack of research into the “material” have begun to study “material practices.” In a characteristically cheeky way, Pinch rightly asks, “What exactly do [scholars] mean by the ‘material’ in ‘material practices’?” [10] After careful reflection, he notes,

> “The word ‘material’ here seems to signify a practice that is grounded in the everyday, in the world of material things and may involve the exchange or manipulation of material things but by and large the materialness of the things does not itself figure in the analysis.” [11]

To move materiality to a more prominent position in sociology, Pinch reviews studies that chart the development and use of a number of “material artifacts” to show how they are fundamentally transformed by sociological practices and, subsequently, transform them. To make his case he draws on some material artifacts that are physical, like the bicycle (Bijker, 1995) and the car (Kline and Pinch, 1996), some that are digital, like electronic publishing software (Boczkowski, 2004), and some that are in–between like the synthesizer (Pinch and Trocco, 2002), which in its digital (as opposed to analogue) form consists of both hardware and software.

These three examples from management, communication, and sociology, limited though they are, demonstrate that scholars who have spent a good deal of time thinking about “materiality” have a hard time defining it. Most begin with some definition that references physical objects, but in providing empirical examples of “materiality” at play in the world they quickly begin to point to digital artifacts like software.

These examples seem to suggest that perhaps the physical matter out of which objects are constructed is not all that important when defining materiality. Following Pinch, perhaps a better strategy than attempting to define materiality (the noun) — since it seems so messy to do — is to look at how scholars use the adjective “material” when they refer to intangible artifacts, like software. Across a range of disciplines including management, communication, and sociology, but extending to human–computer interaction, science and technology studies, economics, and political science, authors increasingly write with the use of the adjective “material.” As just a few examples, Orlikowski [12] writes about groupware software that the technology embodies “particular symbol and material properties.” She provides several examples of the “material properties” of groupware, which include its features contained in menus embedded in the program. Volkoff, *et al.* [13] describe the enterprise resource planning software that they study as having “material aspects” such as algorithms that allow financial transactions and features that permit only certain people to authorize accounts and payments. Leonardi [14] documents use of a help–desk queuing software used by IT technicians and argues that its “material features” make possible activities such as assigning jobs or documenting what one did to solve a particular used problem.

In each of these examples, the adjective “material” seems to refer to some property of the technology (in these cases, software) that provides users with the capability to perform some action. Calling these properties out with the adjective “material” seems a ploy to remind the reader that the software–in–use does things that cannot be reduced to human intention or action. Pickering [15] expresses this idea quite succinctly: “I find it hard to imagine any combination of naked human minds and bodies that could substitute for a telescope, never mind an electron microscope or for a machine tool, or for an atom bomb.” In other words, calling something material emphasizes its performativity — the notion that it provides people with capabilities that they can use to accomplish their goals (Pickering, 2001).

Yet what are these capabilities, exactly? As we saw above, most authors who proffer either a direct or an associative definition of materiality link the term to matter — tangible stuff. But the empirical studies they offer are often focused on artifacts that have no physical matter — no tangible stuff. From this vantage point, it seems that the traditional view of materiality as "matter" is not appropriate, nor does it convey the importance of software's role in organizing activities. It appears, then, that we have two options. The first is to drop the adjective "material" when discussing digital artifacts. If "material" means "matter" and software has no matter, we are best off to dispense with the inaccurate modifier. But if we think there is something important about software or other intangible artifacts that distinguish them in key ways from patterns of interaction, talk, or other social practices, and that the word "material" points to that distinction, a second option would be to consider how the adjective can be used to represent these differences. In the next section I turn to two alternative definitions of "material" that move the term away from definitions of "matter" and into territory that is more useful for describing what it is that intangible artifacts do for social interaction.

From "matter" to "practical instantiation" and "significance"

The *Oxford English Dictionary* provides three major definitions for the adjective "material." They are:

1. Senses related to physical substance: *Formed by or consisting of matter*
2. Opposed to formal: *Designating the practical aspect of something as opposed to the theoretical aspect*
3. Having significance or relevance: *Of serious substantial import; significant, important, of consequence.*

Each of these definitions provides a different account of what it means for an artifact to be "material." In what follows, I briefly explore each of these definitions and consider the consequences they have for the materiality of intangible artifacts.

1. Senses related to physical substance: *Formed by or consisting of matter*

To be sure, the definition of "material" as a physical substance is the most common. If you were to ask a friend to list the materials that make up an object — say a table — they would have little trouble pointing out the wood used for the flat writing surface, the metal used for the tracks upon which the drawers glide and the plastic used for the handles on those drawers. But, as discussed above, if you asked someone to list the materials that make up a piece of software like Microsoft Word, the task would not be so simple. One might argue that the keyboard upon which one types, the monitor upon which one looks to see the text, and the hard drive upon which the software is stored all have matter and that these tangible artifacts are part of interacting with or experiencing the software. Although critics would be correct that one cannot experience MS Word without a monitor, keyboard or hard drive, the software has no physical matter of its own (even though its code is mediated by electronic signals and it relies on physical artifacts such as disk drives and processors for its execution).

Over the years, researchers have shown that physical artifacts' matter matters for the way people organize their work. Edwards (1979) documented how the introduction of conveyer belts into meat packing plants changed the way that employees conducted their work. The conveyor belt moved at a certain speed and the workers had no ability to change it. If they did not speed up the pace of their

work so as to assure that animal carcasses would not fall off the moving belts they would be fired. The belt was a physical force with which the workers had to contend. Barley (1988) illustrated that a newly implemented computed tomography scanner changed the ways that radiologists worked when performing patient scans. The scanners had new physical properties: a new set of cameras arranged in new layouts to take patient images, and new screens to see the results of the films shot by those cameras. As Barley documents, radiologists were not initially sure how to position patients and read films. The physical nature of the machine required a change to the way work was conducted.

In both cases above, workers had to contend with the physical matter of new technologies. These devices provided hard constraints on the way people worked. Yet authors such as Suchman have argued that the matter that comprises physical artifacts is not, in and of itself, important in shaping human action. Providing the example of a hammer, whose matter consists of steel and wood, Suchman [16] argues: "Although the durable materiality of the hammer supports the statement that it exists before and after the moments of its use, it is nonetheless clear that its status as a hammer rests on its incorporation into the practices of some form or carpentry." Suchman's argument is that the matter of a hammer is of little consequence until it is marshaled in the accomplishment of some human action. In other words, the physical matter of the artifact begins to matter only as one utilizes it to achieve a particular goal. Thus, to understand why the physical matter of Edwards' conveyer belt mattered in the work of meat packers we would need to understand how it was taken up in their work. Similarly, to understand why the physical matter of Barley's scanner mattered in the work of radiologists we would need to explore how it became embedded in their interactions with each other and with other roles at their hospitals.

One could easily substitute a compiler, or a spreadsheet, or a simulation software for the hammer in Suchman's observation and reach the same conclusion: That they have effects on the way people interact only when they are incorporated into people's actions. Consequently, perhaps what matters most about an artifact is not what it's made out of, but what it allows people to do. In an effort to explain how animals perceive their environments, James Gibson, a perceptual psychologist, made a similar point. Gibson [17] observed that that people, surfaces, and objects all offered certain "affordances" for action:

> "If a terrestrial surface is nearly horizontal … nearly flat … sufficiently extended … and if its substance is rigid … then the surface *affords* support … . It is stand–on–able, permitting an upright posture for quadrupeds and bipeds … Note that the four properties listed — horizontal, flat, extended, and rigid — would be *physical* properties of a surface if they were measured with scales and standard units used in physics. As an affordance of support for a species of animal, however, they have to be measured *relative to the animal*. They are unique for that animal. They are not just abstract physical properties." (emphasis in original)

In Gibson's formulation, people do not interact with an object prior to or without perceiving what the object is good for. As he suggests, the physical matter of an artifact exists apart from the people who use it, but that physical matter is infused with meaning "relative to the posture and behavior of the animal being considered." [18] Although the physical matter of an artifact is common to each person who encounters it, the affordances of that artifact are not. Affordances are unique to the particular ways in which an actor perceives materiality. To this end, Gibson [19] offers an explanation of the relationship between matter and affordances:

> "The psychologists assume that objects are composed of their qualities … color, texture, composition, size shape

> and features of shape, mass, elasticity, rigidity, and mobility … But I now suggest that what we perceive when we look at objects are their affordances, not their qualities. We can discriminate the dimensions of difference if required to do so in an experiment, but what the object affords us is what we normally pay attention to."

Because matter can provide multiple affordances, it is possible that one artifact can produce multiple outcomes.

Gibson's work has been most notably applied to discussions of technology by Norman (1990; 1999). Norman argues that good designers purposefully build affordances into artifacts to suggest how its material properties should be used. Norman [20] suggests that affordances are intrinsic properties of artifacts and that the role of design is to make affordances easily perceptible to would–be users. For Norman, affordances are "designed–in" properties of artifacts. The goal of an affordance is to signal to the user what the technology can do and how it is to do that thing. To do this, designers must make affordances easy to perceive: "The designer cares more about what actions the user perceives to be possible than what is true." [21] Users are important to Norman insomuch as they can identify a technology's affordances; however, they play little role in creating affordances. Instead, affordances are created strategically by designers. In this formulation, Norman's argument is different than Gibson's in that Norman claims affordances do not change across different contexts of use; rather, they are always there waiting to be perceived.

Hutchby (2001) seeks a middle ground between these prior views by emphasizing the relational character of affordances. In his view, affordances are not exclusively properties of people or of artifacts — they are constituted in relationships between people and the materiality of the things with which they come in contact. Hutchby uses the term "materiality" as opposed to matter because he believes that people create affordances of both physical and digital artifacts. In this formulation, materiality exists independent of people, but affordances do not. Because people come to materiality with diverse goals (Pickering's useful operationalization of human agency) they perceive a technology as affording distinct possibilities for action. For Hutchby, the affordances of an artifact can change across different contexts even though its materiality does not. Similarly, people may perceive that an artifact offers no affordances for action, perceiving instead that it constraints their ability to carry out their goals.

This discussion of affordances pushes us to ask whether physical matter really matters at all. If what is important about "material" artifacts is how they are perceived and subsequently used, as opposed to what they are made of, then using the adjective "material" to denote that an object has a physical substance would seem relatively unimportant for explaining the contours of social interaction. In other words, researchers who study digital materiality lose little by focusing on contexts in which there is no physical matter. Thus, when those researchers describe digital artifacts as having "material" properties, aspects, or features, we might safely say that what makes them "material" is that they provide capabilities that afford or constrain action.

2. Opposed to formal: ***Designating to the practical aspect of something as opposed to the theoretical aspect***

A second definition of "material" emphasizes the practical instantiation of a theoretical idea. The *Oxford English Dictionary* suggests that this definition of material is used in mathematics when a person "designates a number or a number as applied to a specific set of objects rather than treated abstractly or formally in itself." One might think of justice as an abstract or theoretical construct that is made material through the creation of laws or regulations. Or, one might think of a worth as a theoretical idea that is made material when an item is assigned a specific monetary value. When principles, beliefs, or values are made manifest in some way, they become material.

Consider the work of those who manage the design of new cars. These managers have to assure that engineers are designing all of the vehicle's subsystems in adequate ways. To do so, they might map out a series of procedures that engineers should follow to assure that all of the appropriate design steps have been taken. These procedures, and the relationships between them first exist in some manager's head, then move to talk between managers, and then, after some verbal revision, to a sheet of paper such as the one presented in Figure 1. This figure illustrates the process by which managers believe engineers should set–up a computer simulation model of a crash test. As the process chart illustrates, the engineers should begin by creating new geometry (shape) data or by utilizing existing FE (finite element) models and then move to building a preliminary model. After this, engineers follow steps in a specific sequence until they can measure section forces in the models (how much force a specific area of the model received during impact).

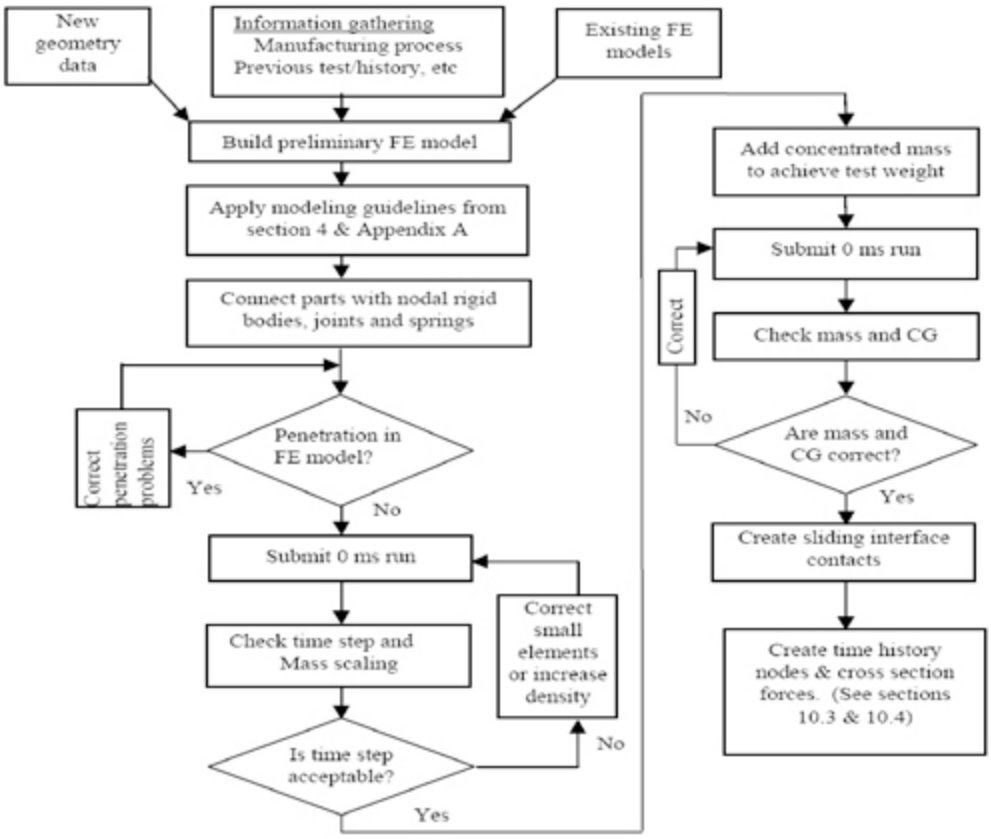

Figure 1: Abstract process for setting up a computer simulation for a crash test.

Although this process model is quite detailed, it is still abstract in the sense that the idea (or its inscription on a piece of paper) goes no distance to ensuring that the steps are actually completed as they are laid out. The idea has yet to become material. In order to give this idea materiality (instantiate it in some way), managers have a number of choices. They could establish a policy indicating that all computer simulations must follow these steps or the engineer's contract with the company would be terminated. They could refuse to look at any results of a simulation that were not generated by setting up the model with the process. Or they could create a piece of software that walks engineers through the process, thus ensuring that it is completed as was desired. Figure 2 provides an image of a piece of software created to make the abstract process material. This piece of

software, called a virtual crash laboratory, guides engineers through each of the steps in the abstract process. The software will not let them move to a new step without completing one that came before it. Consequently, the abstract process of setting up a computer simulation is made material through the software artifact.

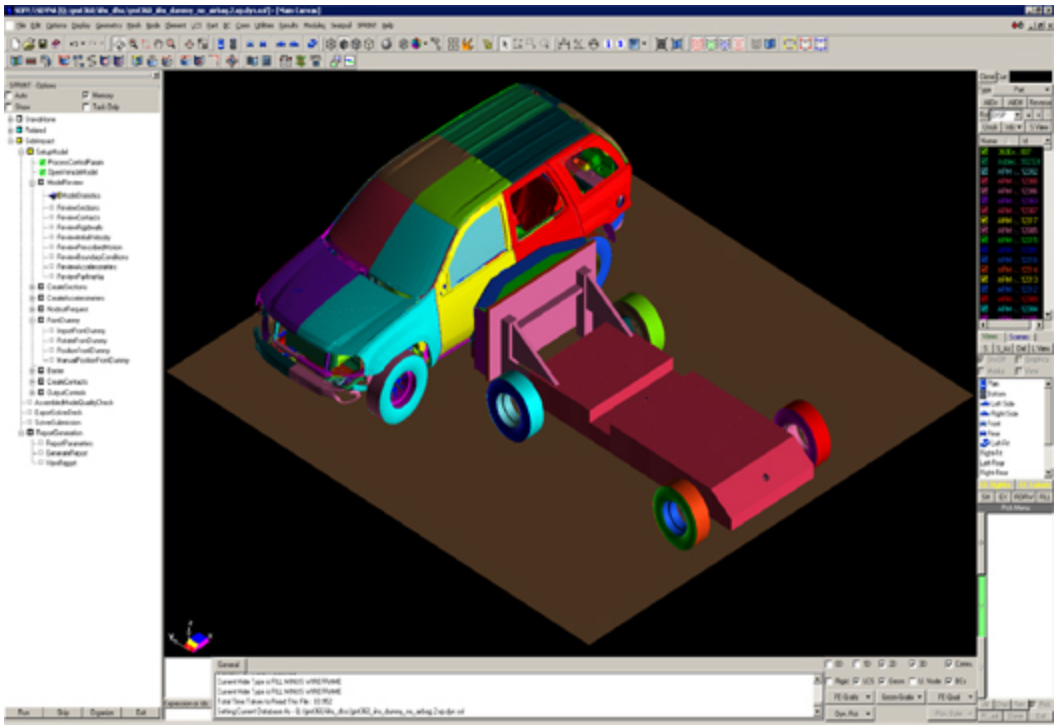

Figure 2: Material instantiation of process in software.

If material is defined as having physical matter, the software is not material. But under the second definition of material, the software clearly helps to instantiate the abstract idea of management. As alluded to above, the software was not the only medium through which the abstract process could become material; organizational policies or specific routines of refusing work could have served this function too. What these policies, routines, and software all have in common is that they exploit some type of social practice that compels people to follow the abstract plan. Thus, to say something is "material" in this definition would be to emphasize its ability to instantiate ideas in practice. Orlikowski's groupware technology could be considered to have "material properties" if those properties permitted the execution of some abstract idea for collaboration. Volkoff, *et al.*'s ERP system would have "material aspects" if it provided facilities to enact inter–departmental coordination. And, Leonardi's help–desk queuing system could be said to have "material features" if it allowed the desired knowledge sharing among technicians.

If one considers materiality using this second definition, it matters little whether an artifact has matter or not. Whether in physical or digital form, an artifact that translates idea into action is material. Of course, not all artifacts make this translation. Even those designed specifically to move thought into the realm of action often fail to do so because people reject them because they cannot understand what value they will bring to their work (Leonardi, 2009) or they use them, but appropriate them in unanticipated ways (DeSanctis and Poole, 1994). In this sense, one could look around at workplace at a number of artifacts, physical or digital, and claim that they are not "material" in the sense that they are not being used to translate some idea into action. This understanding of "material" may help to explain why it is that many software technologies used in

workplaces fail to bring about desired organizational changes (Markus, 2004). Only some artifacts are material, and it is not necessarily those with matter.

3. Having significance or relevance: ***Of serious substantial import; significant, important, of consequence***

The third definition of "material" emphasizes significance. This sense of material is used in law to describe witnesses ("material witness") or facts ("material facts"). Material, when used in this way, refers to only those things (*e.g.*, witnesses or facts) that are pertinent to the task at hand (*e.g.*, proving the defendant's innocence). This sense of the term material is also used in accounting where it refers to the importance or significance of an amount, transaction, or discrepancy. In accounting, what is material is highly subjective, though, according to the Financial Accounting Standards Board a transaction is material if its "omission or misstatement could influence the economic decision of users taken on the basis of the financial statement." [22] In short, this definition suggests that something is "material" if it makes a difference in the current situation.

It is not strange to think that, for a user, some features of an artifact might be material (significant) while others are not. Consider the many features in the photo–editing software Adobe Photoshop. As Figure 3 demonstrates, one can pick from any number of menus and discover a variety of features (*e.g.*, blur, sharpen, pixelate) that can be used at a given time. Some are extremely important to a certain set of users, while others are not. You might imagine that the "blur" feature is important for editors of high school yearbooks attempting to hide blemishes, while the "sharpen" feature is important for law enforcement professionals who are attempting to read the license plate numbers on a passing car. Conversely, if an amateur user is trying to touch up a night–time shot of the Burj Al Arab hotel from his vacation, it is possible that none of these features make a significant difference in his ability to accomplish his goal. Just like a material fact in a case, a piece of software can have certain material features — features that are "more significant" to the user than others. Of course, significance changes across populations of users, and may even change for one user over time. So, researchers should ask, when examining practices of use, which features are "material" (significant) for this user and how those features become significant for the type of work she does, for whom she interact with, or for maintaining control.

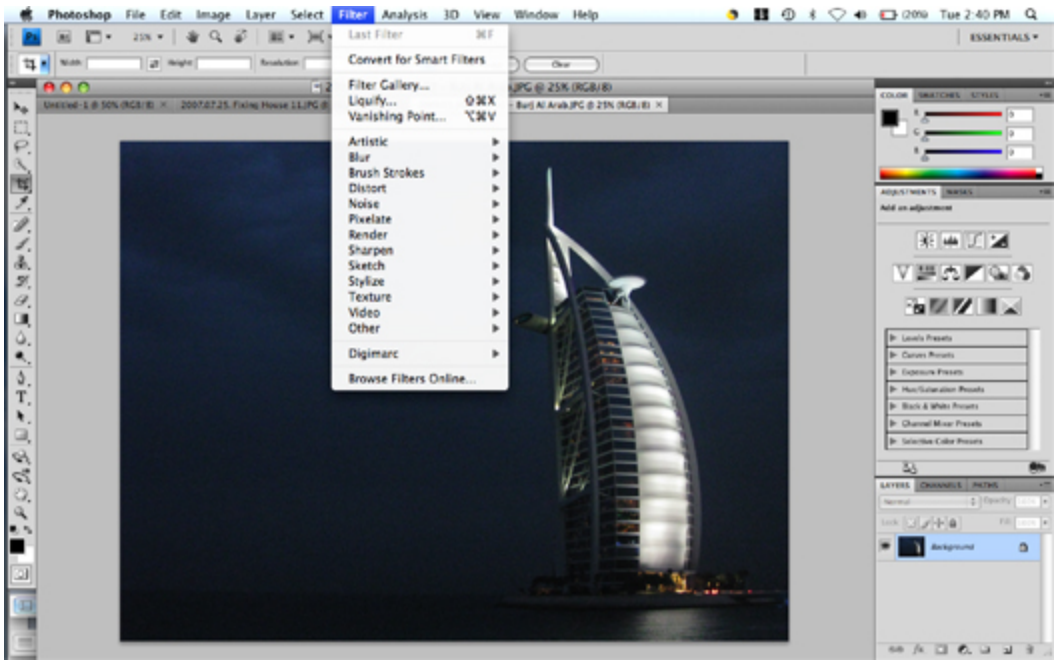

Figure 3: What features are "material" in a digital artifact?

In recent years, Orlikowski's (2000) notion of a technology–in–practice has become common in discussions of technology and organizing. Orlikowski distinguishes a technology–in–practice from a technological artifact. The artifact is the thing that people use. It is the same regardless of who is using it in whatever context. Technology–in–practice refers to the way the technology is used. In the physical realm a chair would be a technological artifact whose form does not change depending upon what office it is in, nor does the steel or wood it is made from. But as technology–in–practice, a chair can be used as a seat, as a ladder, or as a toy (to spin on, of course!). Digital artifacts can also be turned into technologies–in–practice. A user in Chicago who buys Photoshop from the college bookstore gets the same set of features as a user in Tulsa who buys the software from a stand at the local mall. But the same digital artifact can become very different technologies–in–practice as users employ the artifact's features for different purposes, such as those outlined above.

Such a conceptualization of "material" suggests that although an artifact may have many features, not all are equally significant to everyone. Further, not all features are significant for particular purposes. Adopting a definition of "material" as significant, would lead authors to use the adjective in a way that points to those features or aspects of a digital artifact that are significant for accomplishing certain types of work. For example, a pivot table might be a "material property" of MS Excel for a financial analyst while the regression function in Excel's analysis tool pack might be a "material property" for a market researcher. Under the first definition of "material" neither the pivot table nor the regression function would qualify because neither have physical substance. Under the second definition, one might be able to make the case that one or both of these features is an instantiation of a more theoretical idea (*e.g.*, the logic of charts or sampling distributions), but this link is at best, far removed, and at worst, tenuous. Given the third definition of material as significance, neither feature need qualify, but either can depending upon the context in which it is used.

Further, to define significance, one needs to ask, "significant for what?" A pivot table may be significant for persuading a client to invest in an IRA, but it may not be significant for changing the status hierarchy among analysts in a financial consulting firm. This third definition reminds us that a digital artifact, or its features, may be material in some ways, but not in others.

Why focus on different definitions of material?

Over the past decade, students of technology and organizing have labored to describe the relationship between artifacts and informal organizational structures in a theoretically adroit and empirically defensible way, seeking to find some middle ground between extreme positions of determinism, on the one side, and voluntarism on the other. Early work attempted to swing the pendulum away from theoretical explanations that emphasized the logic of determinism. To do so, they conceptualized technology as existing independent of structure, but lacking causal priority; in other words, technology was treated either as an occasion for people to enact new patterns of organizing (Barley, 1986; 1990), or as something that changed organizing practices and was changed by them (DeSanctis and Poole, 1994; Orlikowski, 1992). Both approaches allowed technology an important role in the organizing process while emphasizing the contingent and socially shaped nature of the changes it wrought.

Today, researchers continue to wrestle with the problem of incorporating the materiality of artifacts into voluntaristic theories of change. This problem appears to emerge, in large part, because practice theorists have adopted a definition of structure from structuration theory, which characterizes it as consisting of rules and resources. Moreover, Giddens [23] suggests that "structures refer to a virtual

order of relations," thus, by implication, requiring rules and resources to be of a virtual order too. As Monge and Contractor (2003) suggests, it is easy to conceptualize organizing practices as virtual rules that guide people's understandings of who they should communicate with and what they should communicate about. However, many researchers argue we consider artifacts to be resources that can be drawn upon to alter who people organize, it is not so easy to conceptualize them as having a virtual character because they are "material" (using the first definition) in nature; that is, they have a form and substance that transcends space and time. Thus, as Sewell [24] argues, it is "hard to see how such material resources can be considered as 'virtual,' since material things by definition exist in space and time. It is, moreover, only in particular times, places, and quantities that such material objects can serve as resources."

To deal with this problem that organizing structures can have 'only a virtual existence' [25], but that artifacts have a material (substance) nature, practice–based approaches emphasize that only technologies–in–use, not technological artifacts, can shape organizing processes. In other words, although technologies are material artifacts, their materiality can only bring change if people recurrently enact them as technologies–in–use. Therefore, as Orlikowski [26] argues, it is the technologies–in–practice, not the technological artifacts, that 'are the set of rules and resources that are (re)constituted in people's recurrent engagement with the technologies at hand.'

Such debates over whether or not an artifact can be a resource that people use to change the organizing process are clearly based on a definition of 'materiality' as substance. Some critique this view out of hand because most of the artifacts that researchers today study are digital, not physical, and thus have no substance anyway (Leonardi and Barley, 2008; Vaast and Walsham, 2005). Others critique it instead for its ontological inconsistencies (Woolgar, *et al.*, 2009). But if materiality were to be defined in terms of practical instantiation or significance, voluntaristic theorists would likely have few qualms with it for 'material' would refer not to inherent properties of the artifact, but instead to the way that the artifact exists in relationship to the people who create and use it. These alternative, relational definitions move materiality 'out of the artifact' and into the space of interaction between people and artifacts. No matter whether those artifacts are physical or digital, their 'materiality' is determined, to a substantial degree, by when, how, and why they are used. These definitions imply that materiality is not a property of artifacts, but a product of the relationships between artifacts and the people who produce and consume them.

Researchers frequently lament that studies of the organizing process rarely consider the artifacts that people use when communicating and interacting with others (Fayard and Weeks, 2007; Orlikowski and Scott, 2008; Zamutto, *et al.*, 2007). Orlikowski and Scott [27] observe, for example, that artifacts are 'missing in action' in studies of the organizing process and Leonardi and Barley [28] argue that 'even the most influential studies of organizations and information systems focus primarily on social dynamics or on how people interact with each other around the technology, rather than providing evidence of what specific material features people use.' Pinch [29] perhaps makes the strongest claim when he notes that for traditional sociological studies of interaction and organizing 'the material realm provides an object for signification processes to glob onto, but these processes are independent of the actual working or material composition of the object.' All of these observers suggest that artifacts are overlooked in most research because organizational scholars from varying sociological perspectives all see the 'social' as their object of inquiry and the 'material' as the domain of scientists and engineers. Here, we again see the definition of 'material' as physical substance rearing its head. As Latour (2005) points out, social scientists often have a hard time understanding why they should study the physical when the social sciences spent so many years carving out a mandate for their existence by claiming unique expertise over 'social' and specifying the 'social' as something that exists independently and prior to the physical.

Whatever the reason, it seems true that organizational researchers have largely overlooked artifacts — physical and material — and continue to miss their importance in the organizing process. If it is the case that scholars are leery to journey into the world of the physical, defining "materiality" as

substance only widens the cleavage. But saying that artifacts have materiality in the senses of practical instantiation and significance may seem less strange because these are similar ideas that are used when describing other phenomena like discourse, routines, and institutions, which occupy a central role in organizational theory, specifically and social theory more broadly.

For example, authors such as Fairhurst and Putnam (2004) and Phillips, *et al.* (2004) argue that talk, or discourse with a "little d" brings ideology, or Discourse with "big D" into practice. That is, our everyday talk produces and reproduces ideologies that constrain and enable human action. While ideology exists in the world of theory, it can be practically instantiated in activity through the way people communicate. In this sense, discourse is "material" in the second definition in the same way as artifacts. As another example, Feldman and Pentland (Feldman and Pentland, 2003; 2005) argue that routines have both an ostensive and performative form. In their ostensive form, they are broad theories or plans for action. The ostensive aspect of a routine is instantiated in the world of practice through its performative character. Performing specific steps in the hiring routine activates and grounds the ostensive or theoretical guidelines that routines set forth. Were it not for their enactment in performance, routines' ostensive character would be of little consequence for the organizing process. Put another way, routines are made material when their theoretical guidelines are transformed into specific performances.

Researchers who focus on discourse, routines, and institutions would also feel comfortable talking about their significance. Elsbach (2002) discusses how many institutions exist within organizations such as norms about seating arrangements or standards about acceptable dress, but that not all of them influence the way people perform their jobs. Only some institutions have significant impact, while most do not. In other words, not all institutions are "material" in the sense that they have an impact on people's practices. Similarly, Mumby (1987) discusses that of the many different types of narratives circulating within organizational culture, only some are significant in shaping power relations and creating deference to authority. His analysis shows that not all talk is material in the sense that it can be used to shape action. Some talk is just talk without any particular effect.

As these examples illustrate, researchers who study phenomena central to organization theory, such as discourse, routines, and institutions expend great effort understanding how these phenomena become practically instantiated and theorizing the conditions under which they are significant in producing some type of stasis or change in the way work is organized. Scholars who attend to artifacts could join these conversations more easily if they worked from one of the latter two definitions of materiality instead of insisting that it is matter that matters. Especially in the case of digital artifacts, what may matter most about "materiality" is that artifacts and their consequences are created and shaped through interaction. FM

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Acknowledgments

The author wishes to thank Bonnie Nardi and Jannis Kallinikos for recommending clarifications of the unconventional ideas presented herein. He hopes this paper will spark debate among scholars about how they should think about theorizing the materiality of things they can't touch. A previous

version of this paper was presented at the 2009 meeting of the Academy of Management in Chicago, Ill.

Notes

1. Orlikowski, 2007, p. 1,436.

2. Leonardi and Barley, 2008, p. 162.

3. Orlikowski, 2007, p. 1,436.

4. *Ibid.*

5. Orlikowski, 2007, p. 1,439.

6. Ashcraft, *et al.*, 2009, p. 2.

7. Ashcraft, *et al.*, 2009, p. 24.

8. Pinch, 2008, p. 461.

9. *Ibid.*

10. Pinch, 2008, p. 463.

11. Pinch, 2008, p. 464.

12. Orlikowski, 2000, p. 406.

13. Volkoff, *et al.*, 2007, p. 843.

14. Leonardi, 2007, p. 816.

15. Pickering, 1995, p. 15.

16. Suchman, 2007, p. 21.

17. Gibson, 1986, p. 127.

18. Gibson, 1986, pp. 127–128.

19. Gibson, 1986, p. 134.

20. Norman, 1990, p. 9.

21. Norman, 1999, p. 39.

22. See the Financial Accounting Standards Board's (FASB) Auditing Standards number 47 "Audit risk and materiality in conducting the audit" for further elaboration.

23. Giddens, 1984, p. 304.

24. Sewell, 1992, p. 10.

25. Orlikowski, 2000, p. 406.

26. Orlikowski, 2000, p. 407.

27. Orlikowski and Scott, 2008, p. 434.

28. Leonardi and Barley, 2008, p. 163.

29. Pinch, 2008, p. 462.

References

K.L. Ashcraft, T.R. Kuhn, and F. Cooren, 2009. “Constitutional amendments: ‘Materializing’ organizational communication,” *Academy of Management Annals*, volume 3, number 1, pp. 1–64.http://dx.doi.org/10.1080/19416520903047186

S.R. Barley, 1990. “The alignment of technology and structure through roles and networks,” *Administrative Science Quarterly*, volume 35, number 1, pp. 61–103.http://dx.doi.org/10.2307/2393551

S.R. Barley, 1988. “Technology, power, and the social organization of work: Towards a pragmatic theory of skilling and deskilling,” *Research in the Sociology of Organizations*, volume 6, pp. 33–80.

S.R. Barley, 1986. “Technology as an occasion for structuring: Evidence from observations of CT scanners and the social order of radiology departments,” *Administrative Science Quarterly*, volume 31, number 1, pp. 78–108.http://dx.doi.org/10.2307/2392767

W.E. Bijker, 1995. *Of bicycles, bakelites, and bulbs: Toward a theory of sociotechnical change*. Cambridge, Mass.: MIT Press.

P.J. Boczkowski, 2004. *Digitizing the news: Innovation in online newspapers*. Cambridge, Mass.: MIT Press.

P. Bourdieu, 1977. *Outline of a theory of practice*. Translated by Richard Nice. Cambridge: Cambridge University Press.

G. DeSanctis and M.S. Poole, 1994. “Capturing the complexity in advanced technology use: Adaptive structuration theory,” *Organization Science*, volume 5, number 2, pp. 121–147.http://dx.doi.org/10.1287/orsc.5.2.121

R. Edwards, 1979. *Contested terrain: The transformation of the workplace in the twentieth century*. New York: Basic Books.

K.D. Elsbach, 2002. “Intraorganizational institutions,” In: J.A.C. Baum (editor). *Blackwell companion to organizations*. Oxford: Blackwell, pp. 37–57.

G.T. Fairhurst and L.L. Putnam, 2004. “Organizations as discursive constructions,” *Communication Theory*, volume 14, number 1, pp. 5–26.http://dx.doi.org/10.1111/j.1468-2885.2004.tb00301.x

A.–L. Fayard and J. Weeks, 2007. “Photocopiers and water–coolers: The affordances of informal interaction,” *Organization Studies*, volume 28, number 5, pp. 605–634.http://dx.doi.org/10.1177/0170840606068310

M.S. Feldman and B.T. Pentland, 2005. “Organizational routines and the macro–actor,” In B. Czarniawka–Joerges and T. Hernes (editors). *Actor-network theory and organizing*. Malmö: Liber, pp. 91–111.

M.S. Feldman and B.T. Pentland, 2003. “Reconceptualizing organizational routines as a source of flexibility and change,” *Administrative Science Quarterly*, volume 48, pp. 94–118.http://dx.doi.org/10.2307/3556620

J. Fulk, A.J. Flanagin, M.E. Kalman, P. Monge, and T. Ryan, 1996. “Connective and communal public goods in interactive communication systems,” *Communication Theory*, volume 6, pp. 60–87.http://dx.doi.org/10.1111/j.1468-2885.1996.tb00120.x

H. Garfinkel, 1967. *Studies in ethnomethodology*. Englewood Cliffs, N.J.: Prentice–Hall.

J.J. Gibson, 1986. *The ecological approach to visual perception*. Hillsdale, N.J.: Lawrence Earlbaum.

A. Giddens, 1984. *The constitution of society: Outline of the theory of structuration*. Berkeley: University of California Press.

A. Giddens, 1979. *Central problems in social theory: Action, structure, and contradiction in social analysis*. Berkeley: University of California Press.

E. Goffman, 1961. *Encounters: Two studies in the sociology of interaction*. Indianapolis, Ind.: Bobbs–Merill.

I. Hutchby, 2001. “Technologies, texts and affordances,” *Sociology*, volume 35, number 2, pp. 441–456.http://dx.doi.org/10.1177/S0038038501000219

M.H. Jackson, 1996. “The meaning of ‘communication technology’: The technology–context scheme,” In: B. Burleson (editor). *Communication yearbook*, volume 19. Beverly Hills, Calif.: Sage, pp. 229–267.

R. Kline and T.J. Pinch, 1996. “Users as agents of technological change: The social construction of the automobile in the rural United States,” *Technology and Culture*, volume 37, number 4, pp. 763–795.http://dx.doi.org/10.2307/3107097

B. Latour, 2005. *Reassembling the social: An introduction to actor–network theory*. Oxford: Oxford University Press.

P.M. Leonardi, 2009. “Why do people reject new technologies and stymie organizational changes of which they are in favor? Exploring misalignments between social interactions and materiality,” *Human Communication Research*, volume 35, number 3, pp. 975–984.http://dx.doi.org/10.1111/j.1468-2958.2009.01357.x

P.M. Leonardi, 2007. “Activating the informational capabilities of information technology for organizational change,” *Organization Science*, volume 18, number 5, pp. 813–831.http://dx.doi.org/10.1287/orsc.1070.0284

P.M. Leonardi and S.R. Barley, 2008. “Materiality and change: Challenges to building better theory about technology and organizing,” *Information and Organization*, volume 18, pp. 159–176.http://dx.doi.org/10.1016/j.infoandorg.2008.03.001

M.L. Markus, 2004. “Technochange management: Using IT to drive organizational change,” *Journal of Information Technology*, volume 19, pp. 4–20.http://dx.doi.org/10.1057/palgrave.jit.2000002

P.R. Monge and N.S. Contractor, 2003. *Theories of communication networks*. Oxford: Oxford University Press.

D.K. Mumby, 1987. “The political function of narrative in organizations,” *Communication Monographs*, volume 54, pp. 113–127.http://dx.doi.org/10.1080/03637758709390221

D.A. Norman, 1999. “Affordance, conventions, and design,” *Interactions*, volume 6, number 3, pp. 38–43.http://dx.doi.org/10.1145/301153.301168

D.A. Norman, 1990. *The design of everyday things*. New York: Doubleday.

W.J. Orlikowski, 2007. “Sociomaterial practices: Exploring technology at work,” *Organization Studies*, volume 28, number 9, pp. 1,435–1,448.

W.J. Orlikowski, 2000. “Using technology and constituting structures: A practice lens for studying technology in organizations,” *Organization Science*, volume 11, number 4, pp. 404–428.http://dx.doi.org/10.1287/orsc.11.4.404.14600

W.J. Orlikowski, 1992. “The duality of technology: Rethinking the concept of technology in organizations,” *Organization Science*, volume 3, number 3, pp. 398–427.http://dx.doi.org/10.1287/orsc.3.3.398

W.J. Orlikowski and S.V. Scott, 2008. “Sociomateriality: Challenging the separation of technology, work and organization,” *Academy of Management Annals*, volume 2, number 1, pp. 433–474.http://dx.doi.org/10.1080/19416520802211644

B.T. Pentland and M.S. Feldman, 2007. “Narrative networks: Patterns of technology and organization,” *Organization Science*, volume 18, number 5, pp. 781–795.http://dx.doi.org/10.1287/orsc.1070.0283

N. Phillips, T.B. Lawrence, and C. Hardy, 2004. “Discourse and institutions,” *Academy of Management Review*, volume 29, number 4, pp. 635–652.

A. Pickering, 2001. “Practice and posthumanism: Social theory and a history of agency,” In: T.R. Schatzki, K. Knorr Cetina, and E. von Savigny (editors). *The practice turn in contemporary theory*. London: Routledge, pp. 163–174.

A. Pickering, 1995. *The mangle of practice: Time, agency, and science*. Chicago: University of Chicago Press.

T. Pinch, 2008. “Technology and institutions: Living in a material world,” *Theory and Society*, volume 37, pp. 461–483.http://dx.doi.org/10.1007/s11186-008-9069-x

T.J. Pinch and F. Trocco, 2002. *Analog days: The invention and impact of the Moog Synthesizer*. Cambridge, Mass.: Harvard University Press.

M.S. Poole and G. DeSanctis, 1992. “Microlevel structuration in computer–supported group decision making,” *Human Communication Research*, volume 19, number 1, pp. 5–49.http://dx.doi.org/10.1111/j.1468-2958.1992.tb00294.x

R.E. Rice and J.A. Danowski, 1983. “Is it really just a fancy answering machine? Comparing semantic networks of different types of voice mail users,” *Journal of Business Communication*, volume 30, pp. 369–397.http://dx.doi.org/10.1177/002194369303000401

T.R. Schatzki, 2005. “The sites of organizations,” *Organization Studies*, volume 26, number 3, pp. 465–484.http://dx.doi.org/10.1177/0170840605050876

W.H. Sewell, 1992. “A theory of structure: Duality, agency, and transformation,” *American Journal of Sociology*, volume 98, number 1, pp. 1–29.http://dx.doi.org/10.1086/229967

L. Smircich, 1983. “Concepts of culture and organizational analysis,” *Administrative Science Quarterly*, volume 28, pp. 339–358.http://dx.doi.org/10.2307/2392246

A. Strauss, 1978. *Negotiations: Varieties, contexts, processes, and social order*. San Francisco: Jossey–Bass.

L. Suchman, 2007. *Human–machine reconfigurations: Plans and situated actions*. Second edition. Cambridge: Cambridge University Press.

L. Suchman, 2000. “Organizing alignment: A case of bridge–building,” *Organization*, volume 7, number 2, pp. 311–327.http://dx.doi.org/10.1177/135050840072007

E. Vaast and G. Walsham, 2005. “Representations and actions: The transformation of work practices with IT use,” *Information and Organization*, volume 15, pp. 65–89.http://dx.doi.org/10.1016/j.infoandorg.2004.10.001

J. Van Maanen, 1975. “Police socialization: A longitudinal examination of job attitudes in an urban police department,” *Administrative Science Quarterly*, volume 20, pp. 207–228.http://dx.doi.org/10.2307/2391695

O. Volkoff, D.M. Strong, and M.B. Elmes, 2007. “Technological embeddedness and organizational change,” *Organization Science*, volume 18, number 5, pp. 832–848.http://dx.doi.org/10.1287/orsc.1070.0288

K.E. Weick, 1979. *The social psychology of organizing*. Second edition. Reading, Mass.: Addison–Wesley.

S. Woolgar, C. Coopmans, and D. Neyland, 2009. “Does STS mean business?” *Organization*, volume 16, number 1, pp. 5–30.http://dx.doi.org/10.1177/1350508408098983

R.G. Zamutto, T.L. Griffith, A. Majchrzak, D.J. Dougherty, and S. Faraj, 2007. “Information technology and the changing fabric of organization,” *Organization Science*, volume 18, number 5, pp. 749–762.http://dx.doi.org/10.1287/orsc.1070.0307

Editorial history

Paper received 4 May 2010; accepted 10 May 2010.

Digital materiality? How artifacts without matter, matter
by Paul M. Leonardi.
First Monday, Volume 15, Number 6 - 7 June 2010
https://firstmonday.org/ojs/index.php/fm/article/download/3036/2567