January 2011

Reconciling the Social/Human and Technical/Material in IS Research without Trying too Hard

Steven Alter
University of San Francisco, alter@usfca.edu

Reconciling the Social/Human and Technical/Material in IS Research without Trying too Hard

Steven Alter
University of San Francisco
alter@usfca.edu

Abstract

This contribution to the SIGPHIL workshop on reconciling the social and technical in IS research proposes a sociotechnical approach that addresses many issues related to the long-standing duality of the social/human versus the technical/material. It shows that a sociotechnical approach based on work system concepts 1) highlights and potentially bypasses extremely basic ontological stumbling blocks in IS research, 2) incorporates many of the topics and concerns of the original sociotechnical school, 3) illuminates issues related to the duality of the social/human versus the technical/material, and 4) addresses these topics using concepts and terminology that are much easier to understand than the highly sophisticated concepts in the emerging discourse about sociomateriality. While not starting with assumptions such as the constitutive entanglement of people, technologies, and organizations, this approach addresses some of the topics in the sociomateriality discourse and leads to interpretations that may be useful to that discourse as it continues to unfold. After illustrating the IS discipline's pervasive problem of accepting fundamentally different meanings for the same concepts, it shows that the work system framework, work system life cycle model, and a metamodel underlying the work system framework provide a useful scaffolding for examining and interpreting the duality of social/human versus technical/material in real world situations.

Steps toward Reconciling the Social/Human and the Material/Technical

Questions about the intersection of the social/human and technical/material in relation to information systems go back to early sociotechnical research, include vigorous debates about actor network theory, structuration theory, and related topics. More recently these questions have reemerged in the form of research related to sociomateriality. The description of the AIS-SIGPHIL workshop at ICIS 2011 quotes the Call for Papers for *MIS Quarterly's* Special Issue on Sociomateriality by saying "since its infancy, IS research has struggled to reconcile the technological and the human/social nature of information systems, and to investigate them in a comprehensive and coherent way." *MIS Quarterly's* Call for Papers goes on to say, "Most IS research assumes a conventional duality between the technological (material) and the social/human. ... As we understand the intimate tangle of IS and organizations, their co-emergence, co-production, and mediation, it becomes more urgent for the 'conceptual bubble' of the social/material duality to be burst (Woolgar 2002)." (Cecez-Kecmanovic et al. 2011)

According to *MIS Quarterly's* Call for Papers, it is possible to bypass the social/material duality through the notion of sociomateriality, which "implies that things, technologies, people, and organizations do not have inherently determinate meanings, boundaries, or properties. ... Technologies, people, and organizations are seen as constitutively entangled, implying that we can separate them only analytically." Orlikowski and Scott (2008) refers to "the inherent

inseparability of the social and the technical" (p. 456) and say that within the lens of sociomateriality, "humans/organizations and technology are assumed to exist only through their temporally emergent constitutive entanglement." (p. 457) Feldman and Orlikowski (2011, p. 18) recognizes some of the difficulty of pursuing this approach, saying that "it is unsettling to take on the notion that a resource is defined not by what it *is* but by the practices through which it is enacted as a resource, and that such enactment as a resource is an ongoing and thus necessarily temporary accomplishment. ... The premise that characteristics and capabilities of technologies are relational and enacted in practice is a challenging one to absorb when confronted with the manifest physicality of assembly lines, CT scanners, and computers." Such difficulties lead theorists to create new words such as habitus and structuration, and sometimes "to write sentences that seem to go in circles: 'structured structures predisposed to function as structuring structures' (Bourdieu 1990, p. 53) or 'structure as the medium and outcome of the conduct it recursively organizes' (Giddens 1984, p. 374)." (p. 18).

Why does the reconciliation need to be so difficult? As a contribution to a workshop that "compares traditional sociotechnical approaches with the emerging sociomaterial approach," this paper shows how past research on the work system method provides a way "to reconcile the technological and the human/social nature of information systems, and to investigate them in a comprehensive and coherent way." The basis of the reconciliation is two broadly applicable, easily used frameworks. One describes the relatively static structure of systems in organizations; the other describes the evolution of systems through life cycles that combine planned and emergent change. Those frameworks provide a scaffolding (Orlikowski 2006) for looking at work system operation and work system evolution in more depth. The resulting vocabulary and descriptions demonstrate limitations of social/human vs. material/technical dualities. For example, in many situations the duality between human agency and machine agency lacks what might be called the requisite variety (Ashby 1962) needed to describe and understand systems in practice. A more complete understanding calls for supplementing human vs. machine agency with other forms of agency such as the agency of information and the agency of processes, both of which have the power to impel and/or constrain action in specific situations. Likewise, a work system perspective clarifies the extent and temporality of the "inseparability of the social and technical" and the "constitutive entanglement of people, technologies, and organizations" both of which have been described in locally situated examples that cover short time spans of minutes or hours and in globally distributed examples that unfold over the course of years. Furthermore, a work system approach avoids the problems noted by Leonardi and Barley (2008, p. 159) in the common tendency to "conflate the distinction between the material and social with the distinction between determinism and voluntarism." With that conflation, the material incorrectly seems to imply determinism in the impacts of technology, and the social incorrectly seems to imply voluntarism in the use of technology. With a work system approach, the application of technology depends on a combination of built-in capabilities and human perceptions of the affordances and constraints of specific technologies in specific situations. The voluntary or mandatory use of technology is built into the design of the work system.

This paper is organized around four steps toward reconciling the social/human and the material/technical in IS research:

- **Clarify system-related terminology**. It will be difficult to reconcile the social/human and the material/technical unless basic ontologies in the IS discipline clarify the meaning of concepts that currently have multiple, contradictory interpretations, making it unclear whether examples in the IS field actually represent the phenomena they purport to represent.

- **Take a system viewpoint by thinking of systems in organizations as work systems**. The work system framework provides a system perspective that automatically leads toward reconciling the social and technical because both play roles within a work system, at least by default. (Information systems are work systems devoted to processing information.)
- **Recognize that system life cycles combine planned change and emergent change**. The work system life cycle model assumes that social/human and the material/technical concerns are important in a work system's iterations of planned change and emergent change.
- **Use a metamodel that links the social/human and material/technical**. Instead of trying to reconcile the social/human and material/technical by focusing on debatable dualities, and instead of trying to reconcile the two by assuming that they are constitutively entangled, use a metamodel that recognizes both the distinctions and interactions between the social/human and material/technical. Some (but not all) of the issues addressed under the umbrella of sociomateriality can be interpreted and/or questioned using relationships within that metamodel.

This paper was written on short notice as a contribution to a SIGPHIL workshop at ICIS 2011. It could be developed into a much longer paper that would go into greater depth and would include many of the references that the current manuscript lacks. This paper's more limited goal is to show how existing ideas related to work systems provide a potentially valuable path toward reconciling the social/human and the material/technical.

1. Clarify System-Related Terminology

It doesn't require a semiotician to recognize that the widely accepted use of multiple contradictory meanings of common terms is an obstacle to successful IS practice and IS research. After noticing contradictory meanings of common terms in successive articles in *Communications of the Association for Information Systems* (CAIS), over a decade ago I wrote a paper called "Same Words, Different Meanings: Are Basic IS/IT Concepts our Self-Imposed Tower of Babel?" (Alter, 2000). That paper noted that the IS field seems "terribly concerned with issues of rigor versus relevance, ... It is very hard to be rigorous with slippery concepts that legitimately mean different things to different people" (p. 32). Multiple contradictory meanings are also an obstacle to the creation of Hirschheim and Klein's (2003, p. 263) vision of "a theoretically appealing, yet practically relevant, action – oriented body of knowledge ... a type of 'Rosetta Stone' for IS as an applied discipline."

The inclusion or exclusion of human and social issues in descriptions and analysis of systems is probably the most important area where contradictory meanings abound and flourish. Treatment of "the system" as a technical entity is fundamental to most systems analysis and design textbooks and methods even if they profess concerns about human, organizational, and business issues. The term "system" is open to question in IS research as well. For example, Allen Lee recently noted that IS research has "taken for granted many of its own concepts," and that "it is no exaggeration to describe most IS researchers as having used the term 'system' or 'systems' to refer to just about anything that involves electronic information processing." (Lee, 2010, p. 339) A paper called "Desperately Seeking System Thinking in the IS Discipline" (Alter, 2004) distinguishes between system thinking and tool thinking, and argues that most of the IS discipline emphasizes tool thinking. Lee (2010, p. 341) goes further by saying, "the conflict between the information system discipline's espoused theory of itself as a systems discipline and its theory-in-use of itself as a non-systems discipline has the obvious detrimental consequence in

which much information systems research does not qualify as truly information *systems* research."

Table 1 demonstrates that "same words, different meanings" is still common in the IS discipline, and is especially relevant to terms that might refer to either sociotechnical or purely technical systems. Basic questions about each of the terms boil down to whether one is speaking about a configuration of hardware and software that is used by people (designated "Tech" in Table 1) or a sociotechnical system with human participants (designated "Sociotech" in Table 1).

Reconciling the social/human versus material/technical in relation to basic concepts. A quick glance at Table 1 demonstrates the futility of any attempt to reconcile the social/human versus material/technical without clarifying the meaning of basic terms. The work system ideas summarized in the sections following this very long table point suggest a preferred stance in relation to each of the choices in Table 1. In each case, the sociotechnical choice (or one of several sociotechnical choices in several instances) is appropriate if one is using a work system perspective or something like it. The technical choices are more appropriate for research on conceptual modeling, software design, or other topics more directly related to producing software. In other words, any attempt to reconcile the social/human and material/technical should be clear about its own terminology even though neither approach is preferred for all situations. A full discussion of specific choices in Table 1 is beyond this paper's scope.

Table 1. Alternative definitions or assumptions about common terms related to sociotechnical and technical systems

Term	***Alternative assumptions or definitions*** *"Tech" denotes focusing on hardware/software configurations that are used by users.* *"Sociotech" denotes focusing on sociotechnical systems with human participants.*
Nature of systems	**(Tech)** A system is a hardware/software configuration characterized in terms of usability and used by users, essentially a tool, as explained in Alter (2004). **(Sociotech)** A system is a sociotechnical system that includes human participants and is not used by users. (essentially a system in an organization)
Nature of information systems	Alter (2008, pp. 449-450) lists numerous definitions of information system along a dimension from social to technical. **(Tech)** A hardware/software configuration that captures, transmits, stores, retrieves, deletes, manipulates, and/or displays information; characterized in terms of usability and used by users **(Sociotech)** A sociotechnical system that includes human participants and that captures, transmits, stores, retrieves, deletes, manipulates, and/or displays information. Is not characterized by usability and is not used by users even though the technology and information inside the system is characterized in terms of usability and usage.
Separation of the social and the technical in sociotechnical systems.	**(Sociotech)** Sociotechnical systems should be viewed as work systems that have human participants. (Alter 2010a) **(Sociotech)** A sociotechnical system can/should be divided into a social system and a technical system that can be analyzed separately. (e.g., Hirschheim and Klein's (1994) summary of Mumford's ETHICS (Effective Technical and Human Implementation of Computer Systems) method (Mumford and Weir, 1979))

Evolution of systems over time	**(Tech)** A system is designed by designers whom management has given authority to design the system. **(Sociotech)** A system evolves over time through a combination of planned and emergent (unplanned) change.
Processes and Activities (Precise definitions or approximate descriptions?)	**(Tech)** The activities performed by a system can be described as a process consisting of steps that can be specified clearly and that are followed dutifully by people and/or performing the work. **(Sociotech)** The activities performed by a system can be described as a set of organized and somewhat related activities that rely heavily on human judgment and improvisation (e.g., Hall and Johnson, 2009; Hill et al., 2006) and therefore may not be structured enough to qualify as a process. **(Sociotech)** Much of the work performed in real world situations can be described as bricolage (Ciborra 1999, 2002) in which people performing work make do with whatever human, physical, and informational resources are available, in which adaptations and workarounds often play an important role, and in which contingencies and unexpected conditions often call for adaptations and workarounds that may not have been anticipated when the system was designed. Those adaptations and workarounds result from a combination of technical glitches, cumbersome procedures, imperfect reward systems, incomplete monitoring systems, and effects of alignment or misalignment of personal and enterprise goals.
Participant vs. user	**(Tech)** Systems are hardware/software configurations that are used by users. **(Sociotech)** Work systems have human participants who perform processes and activities within the work system. Those participants may be users or non-users of IT. They may be customers of the work system. Failure to include participants in an analysis automatically would omit important sources of variation in the results.
Capabilities of participants or users	**(Tech)** Both participants and users understand their assigned roles and are capable of performing those roles in the manner intended by system designers. **(Sociotech)** Both participants and users may or may not understand their assigned roles and may or may not be capable of performing those roles in a manner to intended by system designers.
Intentions of participants or users	**(Tech)** Both participants and users intend to perform work in whatever manner was intended by system designers. **(Sociotech)** Both participants and users will perform work based on a combination of the design of the system, the reward structure, the monitoring system, personal intentions, transient conditions, and other contingencies.
Performance of participants or users	**(Tech)** The actual performance of participant and user roles will conform to expectations of designers. **(Sociotech)** The actual performance of participant and user roles may or may not conform to expectations of designers due to a variety of reasons including variability in human capabilities and intentions.

The information that is relevant	**(Tech)** The information relevant to a system in operation consists of definable informational entities that are captured, transmitted, stored, retrieved, deleted, manipulated, and/or displaying through the use of computers. Typical informational entities include orders, invoices, warranties, schedules, income statements, reservations, medical histories, resumes, job descriptions, and job offers. (Informational entities may contain other informational entities, as when an order contains a line item and a document contains a chapter.) **(Sociotech)** The relevant information is any information, computerized or non-computerized, that plays a significant role in the work systems that are being described or analyzed.
The technology that is relevant	**(Tech)** The relevant technology is information technology in the form of hardware and software. Other technologies are not relevant for describing and analyzing systems. **(Sociotech)** The relevant technology is information technology and any other technologies that play a significant role in the work systems that are being described or analyzed.
Technology as distinct from or entangled with processes	**(Sociotech)** Technologies and processes are entangled. Technologies cannot be understood or analyzed without reference to the processes within which they are used. Processes cannot be understood or analyzed without reference to technologies that they use. **(Sociotech)** Technologies are distinct from processes. A specific technology can be used in many different processes. A specific process can often use different technologies to perform essentially the same steps, as happens when an author writes his/her next book using a new generation of word processing and computing technology. Some of the details a specific activities will be different, but the essence of the overall effort is still about writing the book.
Technologies as tools or automated agents	**(Tech or Sociotech)** Technologies within systems are tools that people use. **(Tech or Sociotech)** Technologies within systems may be tools that people use, and also may be automated agents that perform work autonomously after being triggered by events including direct launch by a user. For example, a doctor listening to a heartbeat uses a stethoscope as a tool. In contrast, an automated alert system may operate autonomously over the course of weeks or months after it is initiated by someone who may or may not be a user of any information that is generated.
Importance of products and services produced by a system.	**(Tech)** The description and analysis of a system focuses primarily on the internal operation of the technology that constitutes the system. Products and services that are produced for customers, and the use of those products and services by customers, is viewed as part of the context and may not be particularly important for analyzing the system. **(Sociotech)** Work systems exist in order to produce things for their customers. Ignoring what a work system produces is tantamount to ignoring its effectiveness. Description and analysis of a work system needs to focus on both the internal operation of the work system and external topics such as the receipt and use of products and services by the work system's customers.

Requirements	**(Tech)** "Functional" hardware/software requirements, such as performing particular software functions in particular ways and "non-functional" requirements such as response time, maintainability, and interoperability of a hardware/software configuration. **(Sociotech)** Business requirements, such as enabling people to make better decisions or reducing turnaround time by 30%.
Service	**(Tech)** "A course-grained, discoverable software entity that exists as a single instance and interacts with applications and other services through a loosely coupled (often asynchronous), message-based communication model." (Brown et al., 2005) **(Sociotech)** "Any act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything." (Kotler and Keller, 2006) **(Sociotech)** "A simultaneous or near-simultaneous exchange of production and consumption, transformation in the experience and value that customers receive from engagement with providers, and intangibility in that goods are not exchanged." (Rai and Sambamurthy, 2006)
Implementation	**(Tech)** A method or architecture for accomplishing something on a computer, e.g., an open source implementation of JavaScript **(Tech)** The process of creating and installing software, e.g., "During systems implementation and operation you turn system specifications into a working system that is tested and then put into use. Implementation includes coding, testing, and installation." (Valacich et al., 2012, p. 15) **(Sociotech)** The process of creating or improving business processes, e.g., implementing the new order entry process in the sales department
Solution	**(Tech)** A proposed hardware/software configuration, possibly purchased from a vendor, such as buying an ERP solution from SAP. **(Sociotech)** Combined organizational and technical tactics for improving business performance or overcoming a business challenge. (e.g., see discussion of solutions in Markus and Mao, 2004)
IT artifact	**(Tech)** A hardware/software configuration characterized in terms of usability and used by users (e.g., Srinivasan et al., 2005, p. 994) **(Sociotech)** "bundles of material and cultural properties packaged in some socially recognizable form such as hardware and/or software" (Orlikowski and Iacono, 2001, p. 121) **(Sociotech)** "the application of IT to enable or support some task(s) embedded within a structure(s) that itself is embedded within a context(s)" (Benbasat and Zmud, 2003, p. 188)

2. Take a system viewpoint by thinking of systems in organizations as work systems.

A second step toward reconciling the social/human and technical/material in relation to information systems is to assume that the unit of analysis is a system including social/human and technical/material elements. One way to be more specific about such systems is to view them as work systems, sociotechnical systems (by default) in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific products and/or services for specific internal or external customers. Almost all value chain systems (e.g., systems for inbound logistics, operations, sales and marketing) and support systems (e.g. systems for procurement and human resources) are IT-reliant work systems but are not IT systems because they are not about IT. Information systems, supply chains, and ecommerce systems are special cases of work systems.

In relation to information systems per se:

- Information systems are a special case of work systems.
- Therefore most of the basic ideas about information systems in general are inherited from ideas about work systems in general.
- Therefore a theoretical understanding of information systems should be based on an understanding of what work systems are, how they can be described, and how their evolution over time can be described.
- By default, work systems are assumed to be sociotechnical systems with human participants, rather than tools with human users. With the exception of concepts related to human participants, most of concepts related to sociotechnical work systems should also apply to totally automated work systems.

Work System Framework. Visualizing roles and impacts of the social/human and technical/material calls for a lens that identifies components of even a basic understanding of a work system. The nine elements of the work system framework (Figure 1) are the basis for describing and analyzing an IT-reliant work system in an organization. The framework outlines components of a static view of a work system. That type of view summarizes its form and function at a point in time and is designed to emphasize business rather than IT concerns. It covers situations that might or might not have a tightly defined business process and might or might not be IT-intensive. Figure 1 says that work systems exist to produce products and services for customers. The arrows say that the elements of a work system should be in alignment.

Each of the nine elements in the work system framework brings a large, broadly applicable set of concepts in categories such as components and phenomena (nouns), activities (verbs), characteristics (adjectives), performance indicators and related metrics (adverbs), general principles, and so on. As a set of classes, special cases of work systems such as information systems, supply chains, and projects should inherit many of those concepts and should also have some concepts that are unique to each special case. In turn, special cases within the special cases should exhibit the same type of inheritance. The possibility that the work system framework might form the basis of an ontology for the information system discipline has been suggested but not yet worked out in detail. An attempt to develop such an ontology might find that the nine elements of the work system framework are too coarse, and that a more detailed metamodel underlying the work system framework might be more effective for that purpose. (Alter, 2010b).

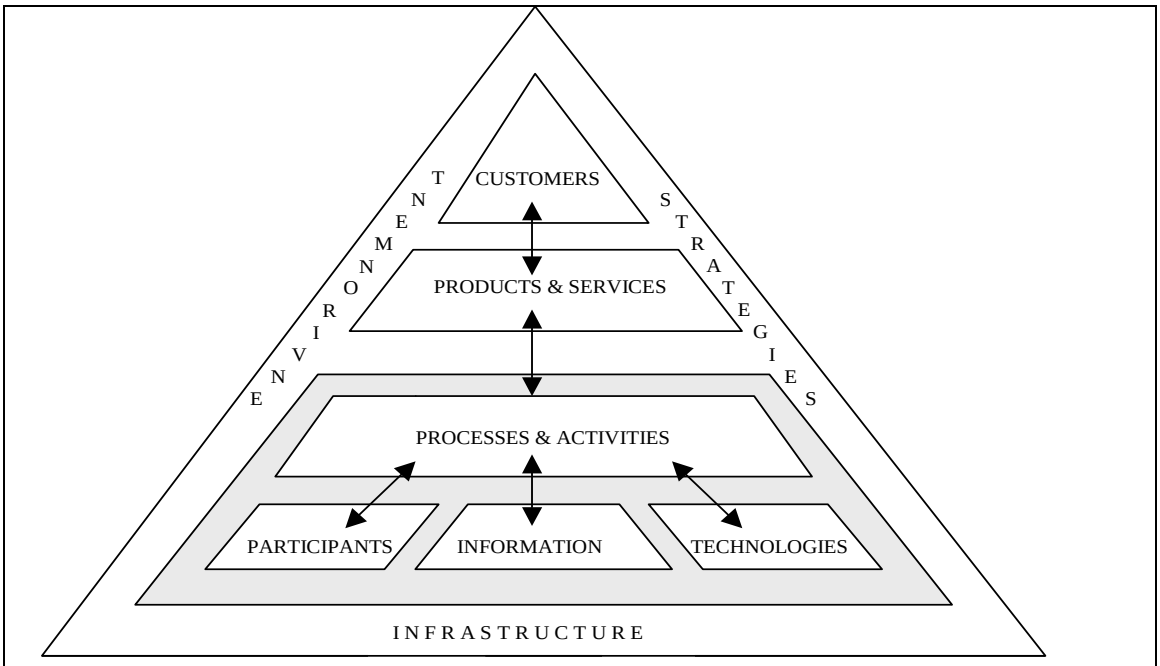


Figure 1. The Work System Framework (as updated in Alter (2008))

Reconciling the social/human versus material/technical in relation to the work system framework. The definitional wholeness of a system consisting of different types of elements implies that the various elements contribute to the whole and ideally should be aligned in purpose and detail. Alignment is not a synonym of reconciliation. Thinking of systems in organizations as work systems implies that there is nothing to reconcile, just as there is no reason to reconcile the existence of arms and legs that are part of a normal human body. Arms and legs have certain capabilities that are unique to arms and legs respectively, but also can be used in combination, and in certain situations can substitute for each other, at least to some extent. There is no reason for reconciliation of the elements of something that is genuinely a system.

Decomposition of sociotechnical systems. The default assumption that work systems have both social and technical elements does not imply that all work systems are sociotechnical, however. The default assumption allows for special cases in which systems are totally social (containing no important technical elements) or totally technical (containing no human participants). Allowing special cases makes it possible to decompose sociotechnical systems for purposes of analysis without worrying about whether a particular subsystem will be totally social or totally technical. It also fits with many current trends in business and society, such as the automation and commoditization (Davenport 2005) of many processes. In relation to reconciling the social and technical, this says that significant parts of systems with social elements may be completely technical and vice versa.

3. Recognize that system life cycles combine planned change and emergent change.

As shown in Figure 2, the work system life cycle model (WSLC) expresses a dynamic view of how work systems change over time through iterations involving planned and emergent change. (Alter 2003, 2006, 2008, 2009). The WSLC differs fundamentally from the "system development life cycle" (SDLC) and other life cycle models related to systems and software. For example, the SDLC is basically a project model rather than a system life cycle. Some current versions of the

SDLC contain iterations, but even those are basically iterations within a project. Second, the system in the SDLC is a basically a technical artifact that is being programmed. In contrast, "the system" in the WSLC is a work system that evolves over time through multiple iterations. In contrast with control-oriented versions of the SDLC, the WSLC treats unplanned or emergent changes as part of a work system's natural evolution.

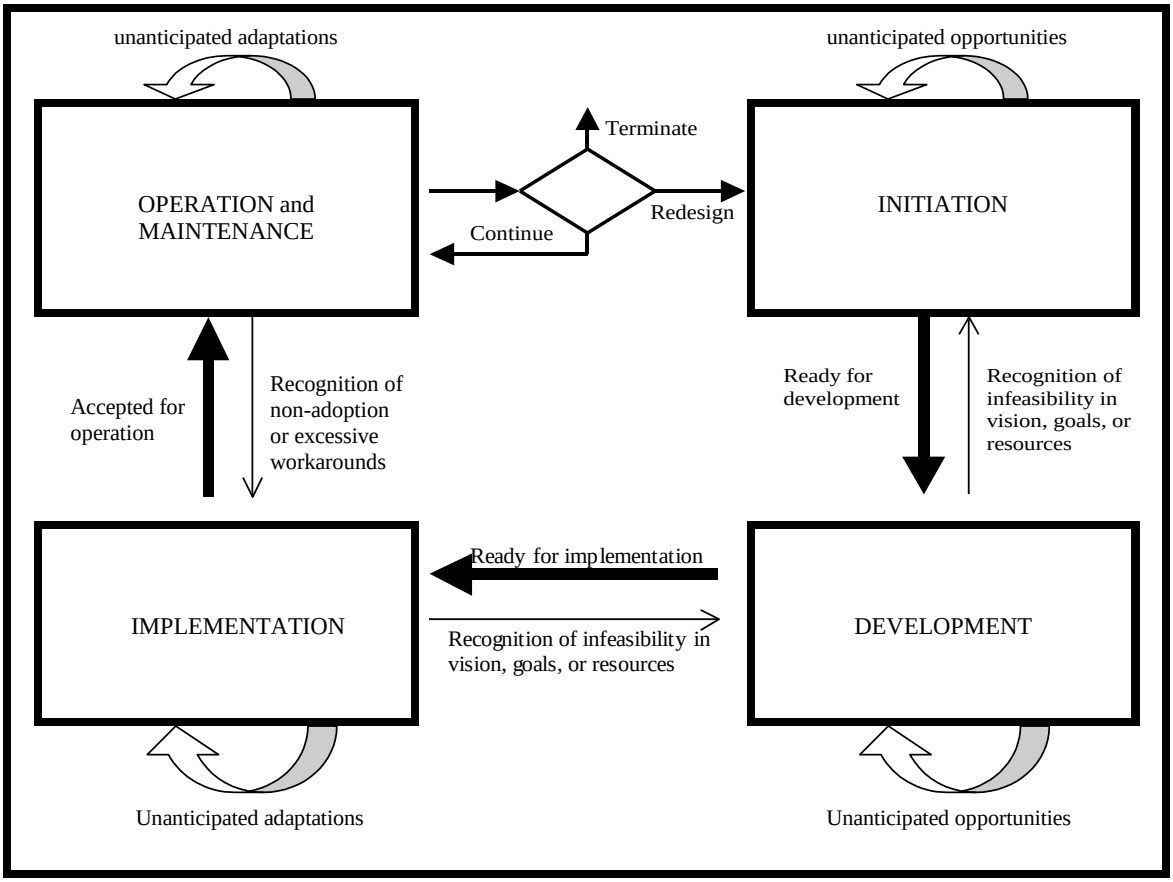


Figure 2. The Work System Life Cycle Model (Alter, 2006, 2008)

Planned change. The WSLC represents planned change as projects that include initiation, development, and implementation phases. Development involves creation or acquisition of resources required for implementation of desired changes in the organization. Development may include any of the following: software development, software acquisition, software configuration, creation of new procedures, creation of documentation and training materials, and acquisition of any other resources needed for implementation of the new version of the work system. In contrast with the view of implementation in most software development methods, implementation in the WSLC means implementation in the organization, not implementation of algorithms on computers. (Markus and Mao (2004) uses the terms development and implementation in a similar way.)

Emergent change. Research that observes interactions between the social/human and the material/technical often tends to emphasize emergent change rather than planned projects. The WSLC represents emergent change using inward-facing arrows that represent ongoing adaptations, workarounds, and experimentation that change aspects of the current work system without separate allocation of significant project resources. The inward facing arrows for all four phases of the WSLC emphasize that emergence occurs not only through incremental changes in

operational systems, but also through changes that occur within different phases of formal projects. The inward-facing arrow for the operation and maintenance phase combines short term adaptations and workarounds of cumbersome processes and longer term changes in practices or goals that occur as adaptations and workarounds become routinized (e.g., Feldman and Pentland, 2003) without requiring formal projects. Emergence during the initiation phase of the WSLC may lead to goals that were not initially anticipated; emergence during the development phase may lead to new understandings and new combinations of functions and issues that were not anticipated in the initiation phase; emergence during the implementation phase may lead to modifications of the initial intentions concerning important aspects of the "to be" work system, including process and activity patterns, uses of technology and information, and expectations related to individual responsibilities and action by participants.

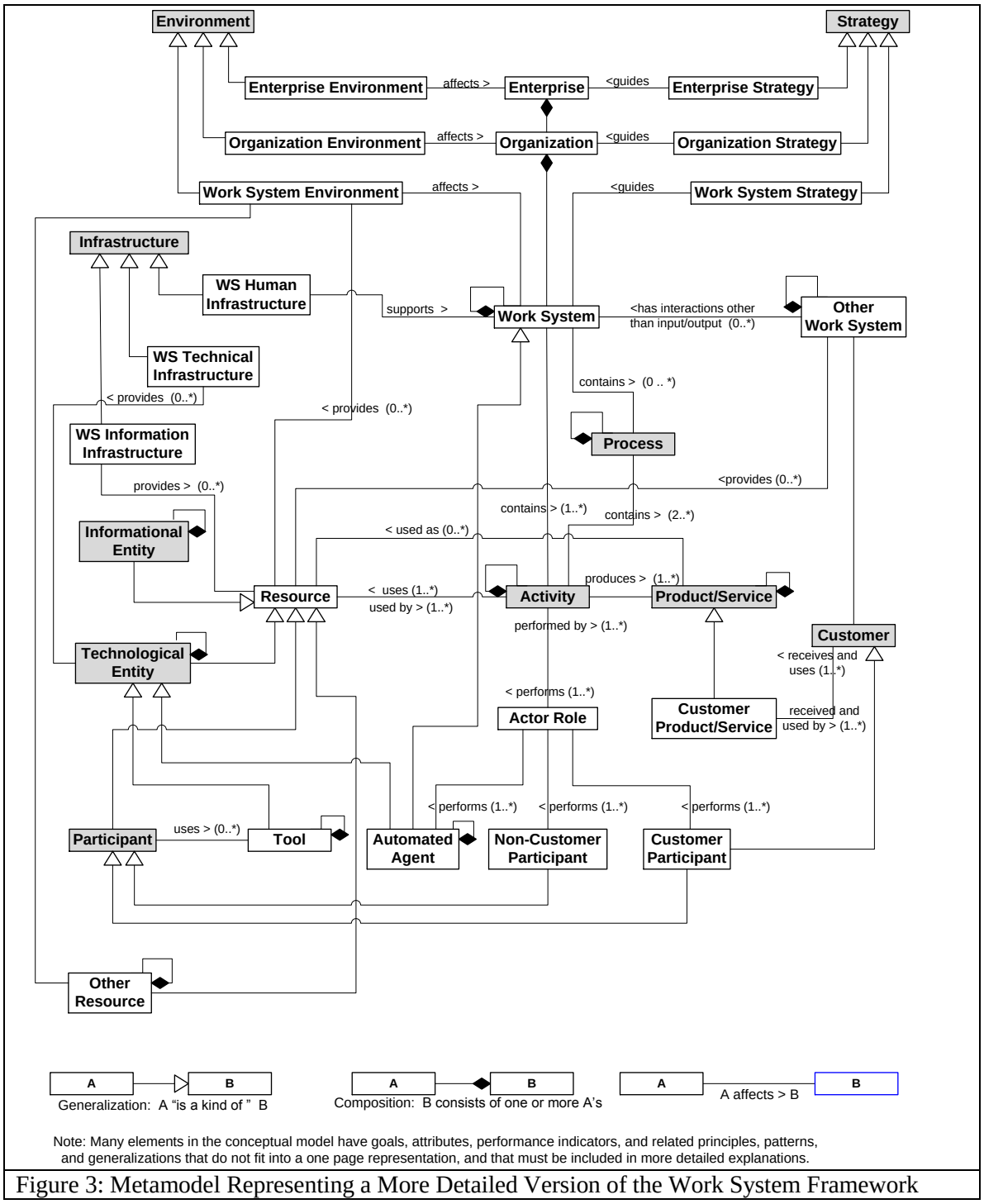
Reconciling the social/human versus material/technical in relation to the work system life cycle model. Both the materiality of technical artifacts and the social aspects of sociomateriality are evident in all four phases of the WSLC. As with the work system framework, there is no need to reconcile the social/human versus material/technical in the WSLC even though it important to recognize factors of both types. Material features affect how easily and how well technical artifacts are used in the operation and maintenance phase. The initiation phase is usually at least partially a response to shortcomings of material features of technical artifacts. (For a description of digital materiality see Leonardi, 2010). The development phase creates material artifacts that may be physical and/or digital. The material capabilities and features of technical artifacts are central topics during the implementation phase. The social parts of sociomaterial concerns are also evident everywhere in the WSLC, including perceptions of and reactions to features, affordances and constraints of specific technologies that are used in the current work system. Those perceptions affect the operation and maintenance of the "as is" work system, the deliberations in the initiation phase, the detailed analysis and technical work in the development phase, and the interactions during technology trials and during the rollout of the "to be" work system within the implementation phase.

4. Use a metamodel that links the social/human and material/technical.

Interactions between the social/human and material/technical are part of a significant and largely unsolved problem in the IS field, the challenge of translating from high level discussions and descriptions of sociotechnical systems into technical documentation that supports the needs of IT professionals, e.g., UML diagrams, BPMN and other notations, diagrams, and methods that make it easier to produce testable software. The metamodel in Figure 3 was developed as a step toward bridging that gap. (Alter, 2010a). It inhabits a rarely visited middle ground between precise documentation that is too abstract and overwhelming for most business professionals and qualitative discussions of capabilities, characteristics, and tendencies that are often insufficient for analyzing or designing technical components of sociotechnical systems.

The metamodel is basically a highly elaborated version of the work system framework (Figure 1) that was designed to be more appropriate for supporting the translation between high level summaries of work systems and more detailed specifications. The metamodel contains 31 entity types and numerous relationships (Alter 2010a, p. 10). Each element of the work system framework is represented in the metamodel, although most are re-interpreted in a more detailed way. For example, information becomes informational entity, technology is divided into tools and automated agents, activities are performed by one of three types of actors, and so on. Whereas the work system framework does not include the term user, the metamodel includes "uses" as a relationship between a participant entity and a tool entity (which is one of two guises of

technology). Goals, characteristics, metrics, principles, and other concepts that pertain to multiple elements and to the work system as a whole are attributes that are not shown in Figure 3, just as attributes and methods for each class in a class diagram might not be shown if the diagram's purpose is to identify the relevant classes and show how they are related to each other. Analysts using the metamodel would consider and apply the hidden attributes while defining the problem or opportunity, evaluating the "as is" work system, and justifying proposed improvements that would appear in the "to be" work system.



Note: Many elements in the conceptual model have goals, attributes, performance indicators, and related principles, patterns, and generalizations that do not fit into a one page representation, and that must be included in more detailed explanations.

Figure 3: Metamodel Representing a More Detailed Version of the Work System Framework

Reconciling the social/human versus material/technical in relation to the work system metamodel. Although the metamodel does not reflect an effort to reconcile the social/human versus the material/technical, many of the topics in that discourse are represented directly or indirectly in the metamodel. Each item in the following set of brief paragraphs says something about how part of the metamodel is related to some aspect of the sociomateriality or human versus technology discourse. A more complete paper would say more about each of the topics and would link the discussion to relevant aspects of the literature.

- **Division of labor between people and technology**. The metamodel says that specific activities are performed by actor roles, and that actor roles are performed by automated agents, noncustomer participants, and customer participants. (The distinction between noncustomer participants and customer participants is included based on theoretical concerns related to service systems that often involve coproduction of value by providers and customers.) An automated agent is a type of technological entity that can perform work autonomously and therefore can be viewed as a work system on its own right. The other type of technological entity is a tool that is used by a human actor, e.g., a doctor using a stethoscope. While division of labor is not a primary topic in the discourse of sociomateriality, it often lurks in the background because of dependency on technology and the possibility that new technologies can augment or replace human capabilities and effort.

- **Affordances and constraints of technology**. Affordances of technologies allow users to do things that they might not otherwise be able to do, whereas constraints of technologies compel users to do work in a particular way or prevent users from doing things that they might want to do. The extent to which built-in capabilities of specific technologies are exercised in specific work systems depends on human perceptions of what those capabilities are and how those perceived capabilities are related to the activities at hand. A specific participant's perception of the usefulness of a particular tool is an attribute of the link in the metamodel between participant and tool. If the work system is largely the product of a formal system design process, related perceptions in the minds of the designers determined the way in which specific technologies were deployed as tools or as automated agents. While perceptions and beliefs about specific technologies in specific situations are important in many ways, it is also true that "a toaster simply cannot be used as a cellphone, no matter how much someone wishes it could be." (Pentland and Feldman 2008, p. 243, cited by Leonardi 2011).

- **Human agency versus technological agency**. The extended debates about human agency versus technological agency may have missed or underplayed of other forms of agency. The bi-directional links in the work system framework (Figure 1) imply a finer grained view of agency since each of the six central elements of the work system framework has mutual impacts with at least one other element, and therefore is affected directly or indirectly by all of the other central elements. In other words, each of the central elements exhibits agency in its ability to perform action or to impel or constrain actions and outcomes. In the realm of work systems, relevant forms of agency include agency of customers (who demand particular levels of cost and quality), agency of products and services (which demand specific types of productive capabilities), agency of participants, agency of information, agency of technology, and agency of other resources (in the lower left of the metamodel) that may impel or constrain action. Identification of those seven types of agency implies that the inherent nature of the social/human versus

material/technical duality lacks the requisite variety (Ashby 1962) needed to describe and understand work systems in practice.

- **Espoused processes vs. enacted processes**. When used in a pure design mode, the metamodel can represent espoused processes that operate in accordance with the designer's intentions. When used in analysis mode, the metamodel can represent either espoused processes or enacted processes. In relation to the WSLC's assumption that work systems are affected by both planned and emergent change, another use of the metamodel is to think about some of the specific adaptations and workarounds that might occur through a combination of the agency of the participants and the contingencies and exceptions that might occur.

- **Technical capabilities vs. technology-in-practice**. The use of technology in a particular situation can be represented using the metamodel as use of built-in technical capabilities or as technology-in-practice. The metamodel encourages consideration of the difference between technical capabilities that are inherent in the technology itself and technology-in-practice, which is revealed at the point where specific activities are performed through the joint agency of technological entities, informational entities, participants, and other resources.

- **Materiality**. The materiality of each element in the metamodel may be relevant to how work system operates and survives. One of the reasons for including "other resources" in the metamodel is that resources other than human participants, technological entities, and informational entities may be part of the relevant materiality that affects whether specific activities can be performed well or performed at all. Examples of other resources include offices, furniture, supplies, and external relationships and commitments.

Unraveling the constitutive entanglement of people, technologies, and organizations. The six types of agency implied by the work system framework (and the seven implied by the metamodel) may also have implications for unraveling aspects of the constitutive entanglement at the core of sociomateriality. Consistent with the metaphor of requisite variety (Ashby 1962), it is possible that teasing apart interactions between the agency of people, the agency of information, the agency of technology, and the agency of processes might help in developing deeper characterizations of what is really entangled and how the entanglement occurs. For example, within specific work systems, interactions between the agency of participants and agency of processes may encounter the agency of specific informational entities at certain points, the combined agency of technology and information at other points, and the agency of unrelated technologies at yet other points, not to speak of other material agencies in which material aspects of the context impel or constrain action. Characterizing such situations only in terms of entanglement between the social and material seems likely to miss important phenomena.

Furthermore, the analytical outlook and purposes of the metamodel raise the question of when entanglement occurs and how long it lasts. Assume that a work system participant uses a specific spreadsheet to perform a particular calculation in part of one activity in a much larger process. Even if that spreadsheet is essential for performing the activity, and even if that spreadsheet could not be used correctly by someone less knowledgeable than this particular work system participant, it would seem an exaggeration to describe the relationship between the user and spreadsheet as constitutive entanglement. But now consider the example of a jet pilot who simply could not fly a particular type of airplane without the advanced control technology built into the airplane. That pilot might view that technology as essential not only to the act of flying a modern aircraft, but also as tightly linked to his or her identity as an expert pilot. And in another example,

consider the mutual relationship between a teenager and the iPhone that he or she uses for looking at Facebook before going to sleep and upon arising in the morning. The teenager certainly seems entangled with the technology in some ways, and that entanglement might continue while the student sneaks glances at Facebook during an uninteresting class, but it probably would be less important at other times (one would hope), such as when the teenager is driving a car.

Conclusion

Instead of assuming that technologies, people, and organizations are "constitutively entangled," and that "things, technologies, people, and organizations do not have inherently determinate meanings, boundaries, or properties," this paper followed Leonardi and Barley's (2010, pp. 34-35) suggestion that researchers should unravel the social and material to study how each contributes to the whole. It presented four steps in that direction:

- Clarify system-related terminology.
- Take a system viewpoint by thinking of systems in organizations as work systems. Use the work system framework (or something like it) to start the unraveling of the social/human and material/technical to see how each contributes to the whole.
- Recognize that system life cycles combine planned change and emergent change that can be described using the work system life cycle model.
- Use a metamodel that links the social/human and material/technical. The metamodel makes it easier to focus in more depth on how different types of agency interact when specific activities are performed, both as designed and in practice.

The title of the SIGPHIL workshop on "Reconciling social and technical in information systems research" seems to assume that it is important to reconcile the social and technical in IS research. This paper's work system orientation assumes that work systems consist of disparate elements, that the performance of work systems is strongly influenced by the alignment and interaction of social/human and material/technical elements, and that evaluating whether the elements fit together in a way that is likely to meet the relevant goals is more important than reconciliation of social/human and material/technical aspects of systems.

The emerging genre of research under the "umbrella" of sociomateriality (Orlikowski and Scott 2008) has already produced interesting insights, new ways of thinking about technology in organizations, and many valuable examples. It would be interesting to apply Figures 1, 2, and 3 to a selected set of those examples and then to compare the interpretations based on sociomateriality with the interpretations based on work system concepts. Ideally the examples would have different temporality, such as examples that exist over the course of minutes, hours, days, weeks, months, and years. Comparison of the interpretations might lead to new insights about the potential value and inherent limitations of sociomateriality viewpoints, system viewpoints, and other viewpoints that might be added to the mix.

References

Alter, S. 2000. "Same Words, Different Meanings: Are Basic IS/IT Concepts Our Self-Imposed Tower of Babel?" *Communications of the Association for Information Systems*, (3:10), pp. 1-87.

Alter, S. 2003. "18 Reasons why IT-Reliant Work Systems Should Replace the IT Artifact as the Core Subject Matter of the IS Field," *Communications of the Association for Information Systems*, (12:23), pp. 365-394.

Alter, S. 2004. "Desperately Seeking Systems Thinking in the IS Discipline," Proceedings of ICIS-25, the International Conference on Information Systems, Washington, DC, pp. 757-769.

Alter, S. 2006. *The Work System Method: Connecting People, Processes, and IT for Business Results*, Larkspur, CA: Work System Press.

Alter, S. 2008. "Defining Information Systems as Work Systems: Implications for the IS Field." *European Journal of Information Systems* (17:5), pp. 448-469.

Alter, S. 2009. "Project Collaboration, not just User Participation," *Proceedings of the Fifteenth Americas Conference on Information Systems*, San Francisco, CA.

Alter, S. 2010a. "Bridging the Chasm between Sociotechnical and Technical Views of Systems in Organizations," *Proceedings of ICIS 2010, the 31st International Conference on Information Systems*.

Alter, S. 2010b. "How Does the Lens of Pragmatism help in Understanding, Using, or Improving Work System Theory?" Proceedings of SIGPrag Workshop. *Sprouts: Working Papers on Information Systems*, (10) 121. http://sprouts.aisnet.org/10-121

Ashby, W.R. 1962. "Principles of the self-organized system," in H. Von Foerster and G. W. Zopf, Jr. (eds.) *Principles of Self-Organization: Transactions of the University of Illinois Symposium*, Pergamon Press: London, UK, pp. 255,-278, reprinted in "Classical Papers - Principles of self-organizing system," *E-CO Special Double Issue*, 6(1-2), 2004, pp. 102-106. Viewed on Sept. 18, 2011 at *http://csis.pace.edu/~marchese/CS396x/Computing/Ashby.pdf*

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

Bourdieu, P. 1990. *The Logic of Practice.* Stanford University Press, Stanford, CA.

Brown, A.W., Delbaere, M., Eeles, P., Johnston, S., and Weaver, R. 2005. "Realizing Service-Oriented Solutions with the IBM Rational Software Development Platform", *IBM Systems Journal* (44:4), pp. 727-752.

Cecez-Kecmanovic, D. Galliers, B., Henfridsson, O., Newell, S., and Vidgen, R. 2011. "Call for Papers, *MISQ* Special Issue On Sociomateriality of Information Systems and Organizing," Call for Papers," *MIS Quarterly*, http://www.misq.org/skin/frontend/default/misq/pdf/CurrentCalls/SI_Sociomateriality.pdf

Ciborra, C. 1999. "Notes on Improvisation and Time in Organizations," *Accounting, Management and Information Technologies*, (9:2), pp. 77-94.

Ciborra, C. 2002. The Labyrinths of Information: Challenging the Wisdom of Systems, Oxford, UK: Oxford University Press.

Davenport, T. 2005. The Coming Commoditization of Processes. *Harvard Business Review*. June 2005.Feldman, M. and Pentland, B.T. 2003. "Reconceptualizing Organizational Routines as a Source of Flexibility and Change," *Administrative Science Quarterly*, (48:1), pp. 94-118.

Feldman, M.S. and Pentland, B.T. 2003. "Re-theorizing organizational routines as a source of flexibility and change." *Administrative Science Quarterly*, (48), pp. 94-118.

Feldman, M. and Orlikowski, W. 2011. "Theorizing Practice and Practicing Theory," Organization Science (22:5), pp. 1312-1321. Draft manuscript, viewed Sept. 10, 2011

http://scholar.google.com/scholar?hl=en&q=Feldman%2C+M.+&as_sdt=0%2C5&as_ylo=2011&as_vis=0 Note: In text references are to manuscript, not final pagination.
Giddens, A. 1984. *The Constitution of Society*. Cambridge, UK: Polity Press.
Hall, J.M. and Johnson, M.E. 2009. "When Should a Process Be Art?" *Harvard Business Review* (87:3), pp. 58-64
Hill, C., Yates, R., Jones, C., and Kogan, S. L. 2006. "Beyond predictable workflows: Enhancing productivity in artful business processes," *IBM Systems Journal*, (45)4, pp. 663-682.
Hirschheim, R., and Klein, H.K. 1994. "Realizing Emancipatory Principles in Information Systems Development: The Case for ETHICS," *MIS Quarterly* (18:1), pp. 83-109.
Hirschheim, R. and Klein, H.K. 2003. "Crisis in the IS Field? A Critical Reflection on the State of the Discipline," *Journal of the Association for Information Systems*, (4)5, pp. 237-293.
Kotler, P. and Keller, K. 2006. *Marketing Management*, 12th ed., Upper Saddle River, NJ: Prentice Hall.
Lee, A.S. 2010. "Retrospect and prospect: information systems research in the last and next 25 years," Journal of Information Technology, (25), pp. 336-348.
Leonardi, P. M. 2010. "Digital materiality? How artifacts without matter, matter, *First Monday*, (15: 6-7), June.
Leonardi, P. M. 2011. "When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies," *MIS Quarterly*, (35:1) pp. 147-167.
Leonardi, P. M. And Barley, S. R. 2008. "Materiality and change: Challenges to building better theory about technology and organizing," *Information and Organization* (18), pp. 159-176.
Markus, M.L. and Mao, J-Y. 2004. "Participation in Development and Implementation – Updating An Old, tired Concept for Today's IS Contexts," *Journal of the Association for Information Systems*, (5:11), pp. 514-544.
Mumford, E. and Weir, M. 1979. *Computer systems in work design – the ETHICS method*, New York: John Wiley & Sons.
Orlikowski, W. J. 2006. "Material Knowing: the scaffolding of human knowledgeability," *European Journal of Information Systems*," (15), pp. 460-466.
Orlikowski, W.J. and Iacono, C. S. 2001. "Research Commentary: Desperately Seeking the "IT" in IT Research - A Call to Theorizing the IT Artifact," *Information Systems Research*,(12:2), pp. 121-134.
Orlikowski, W. J., and Scott, S. V. 2008. "Sociomateriality: Challenging the Separation of Technology, Work and Organization," *Academy of Management Annals*, *(*2:1), pp. 433-474.
Pentland, B. T., and Feldman, M. S. 2008. "Designing Routines: On the Folly of Designing Artifacts, While Hoping for Patterns of Action," *Information and Organization* (18:4), pp. 235-250.
Rai, A. and Sambamurthy, V. 2006. "Editorial Notes – The Growth of Interest in Services Management: Opportunities for Information System Scholars. *Information Systems Research* (17:4), pp. 327-331.
Srinivasan, A., March, S. and Saunders, C. 2005. "Information Technology and Organizational Contexts: Orienting Our Work along Key Dimensions," ICIS 2005, Twenty-Sixth International Conference on Information Systems.
Valacich, J.S., George, J. F., and Hoffer, J.A. 2012. *Essentials of Systems Analysis and Design*, 5th Edition. Upper Saddle River, NJ: Pearson Prentice Hall.
Woolgar, S. 2002. "After Word: On Some Dynamics of Duality Interrogation," *Theory, Culture and Society* (19:5/6), pp. 261-270.