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Sociotechnical Systems through a Work System Lens :A Possible Path for Reconciling System Conceptualizations, Business Realities, and Humanist Values in IS Development

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Abstract. This position paper[1] describes an approach that might increase the likelihood that the sociotechnical perspective will take its proper place in today's world. This paper questions the clarity of the traditional STS notion of joint optimization of a social system and technical system. It explains how the integrated system view in work system theory (WST) and the work system method (WSM) might provide a more straightforward way to describe, discuss, and negotiate about sociotechnical systems. Using WST/WSM to bypass the effort of separately describing and jointly optimizing social and technical systems might make it easier to engage effectively in discussions that reconcile system conceptualizations, business realities, and humanist values in IS development.

Keywords: sociotechnical system, sociotechnical design, joint optimization of social and technical systems, work system theory, work system method

1. Does Existing Sociotechnical Thinking Need an Update?

The CFP for STPIS 2015, the 1st International Workshop on Socio-Technical Perspective in IS Development, says that the socio-technical perspective "is often forgotten in the Information Systems (IS) discourse today." … "We strongly believe

[1] This paper will be presented at STPIS 2015 (1st International Workshop on Socio-Technical Perspective in IS Development) which occurs on June 9, 2015, just before CAISE 2015 (Conference on Advanced Information System Engineering), June 10-12, Stockholm, Sweden. A substantially abbreviated version will appear in the Proceedings.

that it is high time the social-technical perspective took its proper place in IS research, practice and teaching."

A 2006 article by the late Enid Mumford posted on the STPIS 2015 webpage (Mumford, 2006) describes the essence of the sociotechnical approach as follows:

> "Throughout its history, practitioners have always tried to achieve its two most important values: the need to humanize work through the redesign of jobs and democracy at work. In order to realize these goals, the objective of socio-technical design has always been 'the joint optimization of the social and technical systems'. Human needs must not be forgotten when technical systems are introduced. The social and the technical should, whenever possible, be given equal weight." … "The most important thing that socio-technical design can contribute is its value system." … "This tells us that although technology and organizational structures may change, the rights and needs of the employee must be given as high a priority as those of the non-human parts of the system."

After summarizing the founding and application of sociotechnical thinking, Mumford (2006) expresses doubts and disappointment about its limited influence in today's world. This leaves the question of what might be done to help that perspective take its proper place. Voicing doubts from other viewpoints, Sarker et al. (2013) explores whether the academic IS discipline has been faithful to the traditional sociotechnical paradigm and Winter et al. (2014) ask whether the organizational "container" is sufficient for describing sociotechnical work in the 21st century.

Goals and organization. This position paper presents ideas that might help the sociotechnical perspective take its proper place in today's world, which differs greatly from the world that spawned the sociotechnical movement. It explains why the frequently mentioned joint optimization of social and technical is difficult to apply analytically. It summarizes how work system theory (WST) and the work system method (WSM) provide a broadly applicable lens for understanding and designing sociotechnical systems. Overall, it show how a work system lens provides a path for reconciling system conceptualizations, business realities, and humanist values in IS development.

2. Problematic STS Terminology as an Obstacle to Practical Applications

Despite coverage of sociotechnical themes in the first volume of *MIS Quarterly* (e.g., Bostrom and Heinen, 1977), sociotechnical analysis and design methods have not

been prominent in the IS discipline or in IS practice. Mumford (2006, pp. 321-322) describes such methods as follows:

> "The objective of socio-technical design has always been 'the joint optimization of the social and technical systems." …. "Relationships between the two systems, and between them and the outside environment, must also be carefully analysed. This approach led to the development of a complex method for analysing work systems, which went through a number of stages. Unit operations, or groups of tasks that fitted logically together into a discrete work activity, were first identified. Each of these unit operations was made the responsibility of a work group. Next, variances – problem areas where what did happen deviated from what should happen – were noted as areas for improved control by the work group. Supporting activities such as maintenance and the acquisition of supplies were also brought into the analysis. All of these were to become the responsibility of the work group."

Aside from the complexity of that approach, a fundamental problem is that *social system, technical system, work system,* and *joint optimization* are not defined clearly. While practitioners and researchers in the sociotechnical community might take these terms for granted, lack of definition for basic concepts cannot help in explaining this approach to the un-initiated, which is an essential step toward STS taking its proper place in IS research, practice, and teaching.

A possible reason for the lack of clear definition is that the separation between the social system and technical system is largely artificial, as revealed in Figure 1, a diagram from Bostrom & Heinen, 1977a). The social subsystem includes structure and people, whereas the technical subsystem includes technology and tasks. Those distinctions are questionable in many situations.

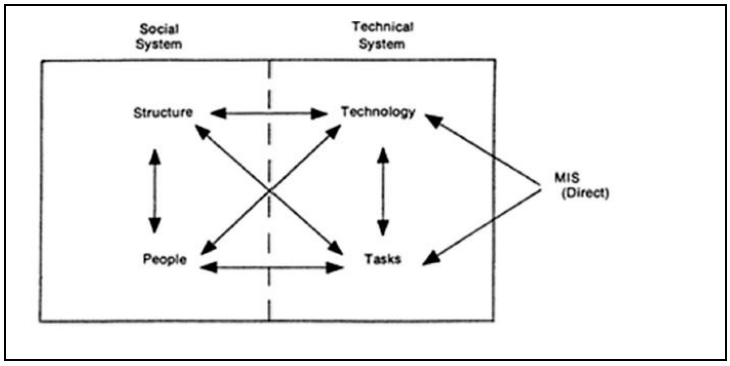


Figure 1. Interacting variable classes within a sociotechnical work system (Figure 1 in Bostrom & Heinen, 1977, p. 25).

Is "Task" technical or social? A business process can be viewed as an abstract specification of the steps in performing work. It seems natural to treat those activities as a technical system if machines perform the work, but it is hard to separate the social from the technical if people perform the work. For example, an ethnographer looking at how work is really done would observe that some of the effort goes into performing specified steps, while other effort goes into coordination, "articulation work," and other activities that are not documented as part of the process. That other effort is clearly social, yet it is an essential part of "the technical system."

Is "Structure" technical or social? Structure-in-practice (assigned to the social system in Figure 1) is a reflection of how tasks (assigned to the technical system) are performed, not just the boxes on an organization chart. Structure is increasingly controlled and/or constrained by the capabilities and limitations of technologies such as ERP software and networks.

Is "Information" technical or social? The ambiguous status of information (not mentioned in Figure 1) contributes to the lack of clarity in the separation between the social and technical. Some information that is stored in computerized databases is easily recognized as part of a technical system, especially if the data was created automatically. Other types of information that are essential for performing work are obviously social, such as conversations, commitments, goals, rules and regulations, institutional memory, and other types of non-computerized information.

Is "Technology" technical or social? With the widespread use of personal computing devices and smart phones, and with the trend toward BYOD (bring your own device), social aspects of the acceptance and use of technology are increasingly important in sociotechnical systems.

What does joint optimization mean? Difficulty defining or separating social and technical systems makes the notion of joint optimization highly problematic. The concept of optimization does not fit well with organization design because the plethora of relevant factors makes it unlikely that anyone would try to find a genuinely optimal solution. (Why talk about optimization if that is an impossible dream?) A more appropriate term is Herbert Simon's concept of "satisficing", i.e., finding a satisfactory solution that is acceptable to most stakeholders and that allows the organization to move forward. Instead of an image of optimization, a more appropriate image is "fit" or "alignment", or in some situations, "negotiated truce." Thus, at least in my personal opinion, collaborating and negotiating about social impacts of processes and technologies in work group and stakeholder meetings is not really a form of optimization.

Is the joint optimization of social and technical systems easy to teach and learn? While full participation of work groups seems an important part of the STS approach, the previously quoted description of sociotechnical design says it is a "complex method for analysing work systems, which went through a number of stages." In other words, complexity could be an obstacle to broader use of sociotechnical design. In turn, that leads me to wonder whether most STS design is actually done by consultants who obtain information from work groups rather than by work groups themselves, which seems more in line with the values of the STS movement.

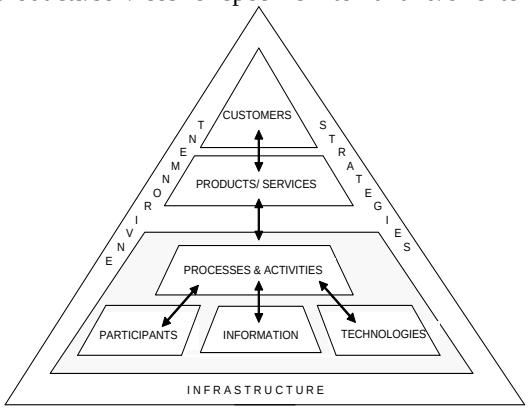
3. Overview of Work System Theory and the Work System Method

Thinking of sociotechnical systems as work systems in the sense of work system theory (WST) and the work system method (WSM) might encourage greater use of sociotechnical ideas and values during IS development, implementation, and use. WST views a sociotechnical system as a work system that is not subdivided into a social system and technical system but whose components may have both social and technical characteristics. A work system is a system in which people and/or machines perform processes and activities to produce product/services for internal and/or external customers. That definition is a step forward because the term *work system* has been used for decades in sociotechnical research without careful definition, e.g., in Volume 1 of *MIS Quarterly* (Bostrom and Heinen, 1977) and more recently in Winter et al. (2104).

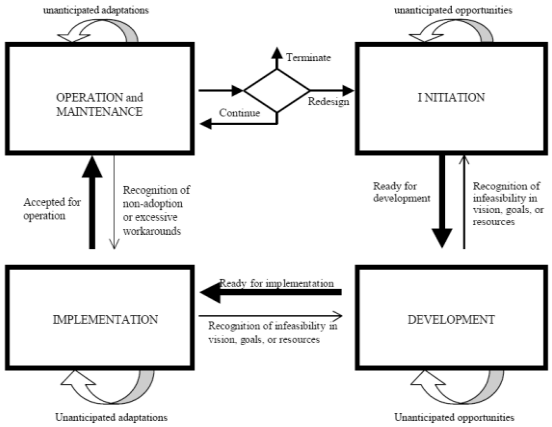
"Work system" is a natural unit of analysis for thinking about systems in organizations. In organizational settings, work is the application of human, informational, physical, and other resources to produce product/services for a work system's customers. Enterprises that grow beyond an improvised start-up phase consist of multiple work systems such as work systems that procure materials from suppliers, produce products, deliver products, find customers, create financial reports, hire employees, and perform other functions.

WST encapsulates a perspective for understanding sociotechnical systems by viewing them as work systems. As illustrated in Figure 2, WST consists of 1) the definition of work system, 2) the work system framework, which provides a static view of a work system during a period when it is relatively stable, and 3) the work system life cycle model (WSLC), which provides a dynamic view of how a work system changes over time. The application of WST in the work system method (WSM) and various extensions of WST are summarized in Alter (2013).

1) Definition of work system: a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific products/services for specific internal and/or external customers.



2) Work system framework



3) Work system life cycle model

Figure 2. Three components of work system theory (Alter 2013)

Work systems, information systems, and sociotechnical systems. Work system is a general case for systems in organizations. Work systems are sociotechnical by default, but can be totally automated based on the definition in Figure 2. Special cases of work systems include:

- Information systems are work systems whose processes and activities are totally devoted to processing information through activities including capturing, transmitting, storing, retrieving, deleting, manipulating, and displaying information.
- Supply chains are inter-organizational work systems whose goal is to provide supplies and other resources required for business operations of customer organizations.
- Projects are temporary work systems that are designed to produce a set of product/ services, after which they cease to exist.
- Totally automated work systems are work systems with no human participants. People who create and maintain these work systems are participants in other work systems that perform those tasks. The trend toward increasing automation of sociotechnical systems requires recognizing both paths toward automation and interactions with automated systems.

Work system framework. This framework (Figure 2) is a basis for describing and analyzing IT-reliant work systems in organizations. Its nine elements organize a basic understanding of a work system by outlining a work system's form, function, and

environment. The framework emphasizes 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. Of its nine elements:

- Processes and activities, participants, information, and technologies are viewed as completely within the work system.
- Customers and products/services may be partially inside and partially outside because customers often participate in the processes and activities within the work system and because product/services take shape within the work system. (The term product/services is used to bypass definitional debates about what constitutes a service.)
- Environment, infrastructure, and strategies are viewed as largely outside the work system even though they have direct effects within the work system. (For example, environment includes organizational culture, politics, history, demographics, competitive situation, etc.)

Figure 2 shows that work systems exist to produce products/services for customers. Analysis and design needs to consider inherent trade-offs between internal concerns about performing the work efficiently and maintaining the morale of the participants versus customer concerns about the total cost, quality, and other characteristics of the product/services that they receive.

Work system life cycle model. The WSLC (Figure 2) describes how work systems evolve through a combination of planned and unplanned change. It differs fundamentally from the "system development life cycle" (SDLC), which is a project model rather than a system life cycle. Even when current versions of the SDLC contain iterations, those iterations are basically within a project. "The system" in the SDLC is a basically a technical artifact that is being created. In the WSLC it is a work system that evolves through iterations that combine defined projects and incremental changes from small adaptations and experimentation. In contrast to the SDLC, the WSLC treats unplanned changes as part of a work system's natural evolution.

Work system method. WSM (Alter, 2006, 2013) is a flexible systems analysis and design method based on WST. It treats the system of interest as a work system. It was created for use by business professionals, and can be used jointly by business and IT professionals in designing work system improvements that may or may not involve software changes. It can be used for high-level guidance in thinking about a work system or can organize a more detailed analysis by using a work system analysis template. It starts from whatever work system problems, opportunities, or issues launched the analysis. A notable aspect of WSM is that the current and proposed systems are work systems rather than configurations of hardware and software.

There are three main commonalities among different versions of WSM. First, the work system's scope is treated as a choice rather a given, typically viewing the work system as the smallest work system that exhibits the problems or opportunities that motivated the analysis. Second, the current and proposed work systems are summarized in the format of a work system snapshot, a one-page summary of the work system's customers, product/services, processes and activities, participants, information, and technologies. Third, performance gaps are identified and alleviated in relation to both internal metrics such as productivity, speed, and error rate and external metrics such as quality, cost to the customer, responsiveness, and reliability.

Extensions of WST. Experience with WSM demonstrated needs for various extensions of WST such as work system principles, work system design spaces, and a work system metamodel that reinterprets and elaborates concepts in the work system framework. The work system principles are partly based on sociotechnical principles from Cherns (1976). Those and other extensions support the description, analysis, design, and implementation of work systems. (Alter, 2013).

Relationship to IS development and systems analysis and design. The mantra that the IS discipline is about sociotechnical systems comes into question in IS development and systems analysis. Most textbooks in those areas teach that systems are technical artifacts that operate through IT hardware, software, network infrastructure, user interfaces, and databases. In practice and in academia, IS development is often viewed as creating and installing technical artifacts whose requirements come from analyzing sociotechnical systems. In contrast, a sociotechnical view of "the system" calls for not only technology changes, but also changes in processes, management, training, social relations, and incentives.

Analysis and design from a work system perspective consistent with the WSLC (Figure 2) and WSM starts with identifying the smallest work system that has the problems or opportunities that launched the analysis. The "as is" system is a work system that requires improvement. The "to be" system is a work system that is more likely to meet performance goals. The analysis focuses on the structure of the "as is" work system (including processes, participants, technologies, and information) and on addressing performance gaps, key incidents, customer needs, and so on. Six Sigma techniques such as Pareto charts, fishbone diagrams, and value stream mapping are just as relevant to the analysis as IT-oriented methods. The resulting project proposal outlines activities for moving from the "as is" work system to the "to be" work system. Production, improvement, or installation of software may be a step toward implementation of the new work system.

Finally, consistent with the sociotechnical principle of incompletion (e.g., Mumford, 2006, p. 323), the inward-facing arrows in the WSLC raise challenges for both

systems analysis and design and system development by saying that emergent change is likely to occur during a work system's natural evolution. Work system designers should not assume that a work system will operate in accordance with idealized specifications after the initial implementation. It is more realistic to assume that emergent change will occur. A potential research direction involves developing guidelines, checklists, and heuristics for identifying likely directions for emergent change and channeling emergent change in beneficial directions.

4. Benefits of Seeing Sociotechnical Systems through a Work System Lens

The previous sections argued that common sociotechnical terminology is problematic and then introduced WST/WSM. This section suggests a path forward by using a work system lens for describing and analyzing sociotechnical systems. This lens could help in making those systems more understandable, in addressing business realities more fully when analyzing those systems, and in supporting some of the humanist values at the heart of the sociotechnical perspective.

4.1 Benefit #1: Sociotechnical Work Systems Will Be More Understandable

Analyzing and designing sociotechnical systems from a work system perspective eliminates the artificial separation between the social system and the technical system. It also eliminates the misnamed concept of joint optimization. Looking at sociotechnical systems from a work system perspective instead of a traditional sociotechnical perspective has the following benefits:

A more practical model. Seeing a sociotechnical system as a single work system is more straightforward than seeing it as a combination of vaguely defined social and technical systems that actually overlap. WST assumes that social and technical issues often are intertwined in work systems. It focuses on why a work system operates as well as it operates and on how to improve it, fully considering social and technical issues but not trying to classify them as social or technical.

An organized approach to business topics. The work system framework outlines elements that must be considered in even a basic understanding of a work system. It does that more clearly than a diagram like Figure 1. The social side is covered by the inclusion of participants and by aspects of the environment, including organizational culture, politics, leadership, ambitions, and other conditions that surround a work system and must be considered when thinking about how to improve it. A work system metamodel (mentioned earlier as an extension of WST) reinterprets each

concept in the work system framework, thereby supporting more detailed analysis. For example, the metamodel calls for identifying which specific informational and physical resources are used by each activity. It also tries to minimize the likelihood of significant omissions by identifying many different types of information such as transaction databases, plans, goals, commitments, business rules, service level agreements, conversations, and so on.

A readily usable analysis method. WSM provides an easily adaptable method for performing the initial analysis of a work system, clarifying its boundaries, and attaining agreement about what system is actually being improved. That type of work system understanding should precede selection or creation of application software. Many hundreds of MBA and Executive MBA students in the United States, China, India, Vietnam, and possibly elsewhere have produced preliminary management briefings suggesting improvements in work systems in their organizations by using WSM via work system analysis templates (e.g., Truex et al., 2010).

Usable without consultants or researchers. Meaningful use of WSM does not require guidance by IT experts, consultants, or researchers even though ideal applications of WSM should involve extensive collaboration between business and IT professionals. WSM evolved over many years based on use of successive versions by employed business students. It is designed to help system participants and other stakeholders think about their own situations in whatever way and at whatever level of depth was useful to them. They also can use it in collaboration with IT professionals or consultants, who in turn could use WST/WSM as a way to establish mutual understanding with everyone involved. Collaborating around improving the performance of current and proposed work systems is a much more direct and practical focus for collaboration than asking work system participants to suggest or evaluate proposed features and benefits of software that might be used in a future version of the work system that has not been described.

4.2. Benefit #2: Analysis and Design Are More Likely to Reflect Business Realities

Using a work system lens to treat sociotechnical systems as integrated entities has many advantages when confronting many of today's sociotechnical systems, which often are different in form and scope from the sociotechnical systems that were the original basis of the sociotechnical approach. This section identifies some of the areas where WST/WSM points directly at issues that might not be highlighted in the same way by sociotechnical analysis and design based on joint optimization of a firm's overlapping social and technical systems.

Customers. The placement of customers at the top of the work system framework is a reminder that work systems exist to produce product/services for internal customers (employees of the firm) and/or external customers. Looking inward and highlighting social and technical systems places the emphasis elsewhere. Note also that customers often are work system participants (e.g., patients in medical exams, students in education, users in IS development), i.e., important parts of sociotechnical systems even though they are not part of the provider's internal social system.

Service systems, co-production, and value co-creation. By many estimates, services comprise 75% of advanced economies. Many service systems such as education, medical care, and customized software production involve co-production by providers and customers. Researchers in marketing and service science go a step further, arguing that many customers actually create value for themselves and highlighting value co-creation opportunities in which service providers become involved in customers' value creating activities. Once again, WST/WSM fits these situations because the main activities occur within provider and/or customer work systems.

Product/services. Neither customers nor product/services appear in the depiction of social and technical systems in Figure 1. Traditional STS approaches tend to look inward and tend not to highlight such topics. Instead of focusing on social versus technical systems, a business-oriented analysis of a work system should focus on trade-offs between the primary concerns of the organization and its employees versus the primary concerns of customers. These are often quite different, with customers often not caring much, if at all, about circumstances under which a provider produces product/services that customers receive and use.

Trans-organizational work. Winter et al (2014, p. 250) notes that "the STS approach encapsulates work and the infrastructure used to do it within organizations (either explicitly or implicitly) — often leading to a "container" view of organizations as the context of work." That article suggests updating the conceptualization of sociotechnical systems "to reflect the role of information infrastructures as an enabler of trans-organizational work arrangements." WST/WSM addresses this need directly because the ideas apply equally to work systems within a firm and work systems such as supply chains that cross organizational boundaries. A work system analysis would identify the processes and activities that are co-located and the other processes and activities that require coordination across distances. Even superficial analysis of a work system would likely identify issues related to social and geographical distance that might be difficult to approach in relation to joint optimization social and technical systems.

Transience and organizational flux. Transience and organizational flux of many types are increasingly common. Many enterprises have experienced significant reorganizations and staff reductions combined with transitions from older product/services to newer types of offerings. Careers are much less stable and predictable. Many job roles have changed, and many of today's jobs did not exist a decade ago. Work is increasingly performed in temporary project teams that are designed to disband when projects end. Even with these trends toward flux at many levels, sociotechnical systems still need to operate efficiently and need to produce product/services that their customers want and need. Use of WST/WSM provides a relatively lightweight approach for describing sociotechnical systems, evaluating how well they are operating, and thinking about possible impacts of changes that are being imposed from outside or are generated internally.

Processes and activities. Processes and activities have changed greatly over recent decades. Many types of work are automated and/or controlled by computers to a greater extent. Computerized transaction processing systems associated with ERP, CRM, and BPM enable tighter work modularization, operational control, and near real time monitoring. Increasing availability of extensive and highly current metrics about many aspects of work enables closer control of quality and consistency, but also leaves many work system participants feeling as though Big Brother is watching, at least in the United States. Those issues would appear in a WSM analysis because the motivation and goodwill of work system participants are important determinants of work system performance.

Outsourcing. Many types of work have been outsourced. WST/WSM views this as another configuration of work in which a work system's product/services are produced in a larger sociotechnical system that spans the original firm and the outsourcing vendor. It is not clear how traditional STS joint optimization would handle those situations, especially when they call for some degree of ongoing monitoring of the work by the original firm.

Workarounds and noncompliance. An extension of WST called the "theory of workarounds" (Alter, 2014) serves as a reminder that work systems as documented may differ from work systems-in-practice even in the presence of computerized tracking. An example is doctors and nurses who sometimes bypass expectations built into electronic medical record systems in order to deal with patients before dealing with data. In such situations, an extension of WST regarding workarounds motivates analysis that might be missed in a joint optimization discussion.

Participants. Instead of seeing themselves as members of social systems, many of today's work system participants see themselves as an endangered species, employees who may not be fully employed tomorrow. Social contact in many work settings is

diminished by working through interaction with computers rather than people. Distributed project teams may have very little social interaction. The value of hard-earned knowledge and skills diminishes as technology and work arrangements change. These issues are as relevant to WST/WSM as to traditional STS.

New technologies. Many sociotechnical systems apply forms of computer and network usage and automation that were almost unimaginable two or three decades ago. The extreme pace of technical change challenges the whole notion of joint optimization because the technologies bring new levels of capability whose impacts may be difficult to anticipate.

4.3 Benefit #3: Humanist Values Are More Likely to Be Recognized in IS Development

Use of WST/WSM could shine more light on the presence or absence of humanist values in IS development. This would occur through a combination of empowerment, awareness, and better communication and collaboration between all stakeholders in sociotechnical systems.

Humanist values in IS development start with empowerment. WST/WSM empowers business professionals by providing an organized approach for thinking about work systems for their own purposes and for collaborating with others. The central focus is on visualizing and analyzing work systems that business professionals live with every day. From that perspective, IS development is about supporting their work systems, something they care about and can discuss knowledgably, with due attention to impacts on positive and negative impacts on people.

Humanist values require recognizing the needs and skills of work system participants. WST/WSM treats human participants as an integral part of work systems, fully recognizing that work system performance depends on how well work system participants' skills, capabilities, interests, and ambitions fit with the characteristics of the rest of the work system.

Humanist values require communication and collaboration. The ability to use an organized approach for thinking about sociotechnical systems implies that business professionals will be more able to communicate effectively about how their roles in those systems affect them and their colleagues. An emphasis on humanist values is less likely to appear prominently in analyses that consultants, researchers, IT professionals, or other outsiders create and bring to work system participants.

5. Recommendations and Conclusion

Involvement of managers and work system participants in designing sociotechnical systems should not assume that consultants, researchers, or IT experts will do system-related thinking for them. This paper's discussion of using a work system lens for understanding sociotechnical systems implies a possible path for reconciling system conceptualizations, business realities, and humanist values in IS development. That path includes the following:

System conceptualizations. Organize the analysis of sociotechnical systems around WST/WSM instead of the joint optimization of partially overlapping social and technical systems.

Business realities. Recognize that IS development should focus on improving the performance of work systems guided by trade-offs between corporate and labor interests versus external customer interests. This involves much more than creating, testing, and implementing information systems and much more than joint optimization of social and technical systems.

Achieving humanist values in IS development. Empower work system participants and other stakeholders by providing concepts and methods that they can use themselves for their own purposes and can also use when collaborating with technical and non-technical colleagues.

There is no guarantee that a WST/WSM approach will succeed where traditional STS has faltered. Work system participants might not seize the opportunity to do more for themselves. At minimum, however, the use of a work system lens for STS brings the possibility of thinking about sociotechnical systems more effectively, reflecting business realities more completely, and achieving greater engagement and focus related to humanist values in IS development.

References

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

Alter, S. (2013) Work System Theory: Overview of Core Concepts, Extensions, and Challenges for the Future. *Journal of the Association for Information Systems*, 14(2), 72-121.

Alter, S. (2014) Theory of Workarounds. *Communications of the Association of Information Systems*, 34(55), 1041-1066.

Bostrom, R.P. and Heinen, J. S. (1977) MIS Problems and Failures: A Socio-Technical Perspective. Part I: The Causes. *MIS Quarterly* 1(3), 17-32.

Cherns, A. (1976) Principles of Socio-technical Design. *Human Relations*, (2)9, 783-792.

Mumford, E. (2006) The story of socio-technical design: reflections on its successes, failures, and potential, *Information Systems Journal*, 16, 317-342.

Sarker, S., Chatterjee, S., & Xiao, X. (2013). How "Sociotechnical" is our IS Research? An Assessment and Possible Ways Forward. *Proceedings of ICIS 2013*.

Truex, D., Alter, S., and Long, C. (2010) Systems Analysis for Everyone Else: Empowering Business Professionals through a Systems Analysis Method that Fits their Needs, *Proceedings of ECIS 2010*.

Winter, S., Berente, N., Howison, J., & Butler, B. (2014). Beyond The Organizational 'Container': Conceptualizing 21st Century Sociotechnical Work. *Information and Organization*, *24*(4), 250-269.