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Work System Theory: An Integrated, Evolving Body of Assumptions, Concepts, Frameworks, and Principles for Analyzing and Designing Systems in Organizations

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This article presents work system theory (WST) as a body of theory for analysis, explanation, prediction, and design and action (Gregor, 2006) related to systems in organizations. It provides background about how WST evolved, summarizes major components of WST, and explains that each of the five types of theory identified by Gregor (2006) appears in WST. The discussion of WST emphasizes its overall contribution to knowledge by emphasizing areas in which it differs from commonly used terminology, frameworks, and beliefs within the IS field. In a discipline in which even basic terms such as system, service, implementation, and user have many contradictory meanings, a key goal of WST is to demonstrate the possibility of using an internally consistent set of assumptions, concepts, frameworks, and principles as a basis for analysis, explanation, prediction, and design and action.

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Toward a Body of Theory about Systems in Organizations

This article presents work system theory (WST) as a body of theory primarily for analyzing and designing systems in organizations, but also containing concepts, frameworks, and principles that can be used for explanation and prediction. Unlike narrower theories that express relationships between several primary constructs, WST is potentially "interesting" (Davis, 1971) as a body of theory in the IS field because it links a well-defined big picture view of IT-reliant systems in organizations with more detailed concepts and theories for analysis, explanation, prediction, and design and action. A number of articles have been published about work systems and topics related to the work system method (e.g., Alter 2003a, 2006b, 2008a, 2008b, 2010a, 2010d; Truex et al., 2010). This article's contributions include explaining WST in the context of theory, describing how its underlying assumptions and premises differ other assumptions and premises that are widely accepted in the IS field, presenting a new concept classification matrix that clarifies WST's scope and possible use for organizing a major part of the body of knowledge for IS, and identifying a number of areas in which WST might be developed further.

WST is conceived as an integrated body of theory that encompasses static and dynamic big picture views of systems in organizations (represented by the work system framework and work system life cycle model) and that provides a scaffolding for additional layers of concepts that support analysis and design efforts and that are useful in research about IT-reliant systems in organizations. WST is a body of theory concerning systems in organizations rather than a body of theory only about information systems per se. This is consistent with suggestions that IT-reliant work systems are the core subject matter of the IS field (Alter, 2003a) and that the IS field should lay claim to systems in organizations (most of which are IT-reliant) as its unique niche in academia (Alter, 2003b). Based on its moderate level of abstraction, WST might be viewed as a *mid-range theory* (Merton, 1968, cited by Gregor (2006)). On the other hand, its very broad scope of application (any system in an organization) might make it seem more like a *grand theory* (Bacharach 1989, cited by Gregor (2006)). Whether or not WST qualifies as a mid-range theory, a grand theory, or an assemblage of assumptions, concepts, frameworks, and principles, it has always had the explicit goal of incorporating concepts that are "rigorous enough," i.e., neither grandiose nor abstruse, but rather, straightforward and readily usable by business professionals, not just Ph.D. researchers.

This article builds on Gregor's (2006) discussion of the nature of theory in IS, and to a lesser extent on views of Weick (1989, 1995) about theorizing and suggestions by Davis (1971), DiMaggio (1995), Grover et al. (2008) and others about what makes a theory interesting. It characterizes WST as a body of theory consistent with Gregor's observation (p. 614) that some comprehensive, well-developed bodies of theory could include components from all five types of theory: theory for analysis, for explanation, for prediction, for explanation and production, and for design and action. Based on Weick's (1989) description of "disciplined imagination" and Weick 's (1995) observations about the process of theorizing and the significance of recognizing "interim struggles" during that process, it traces some of the main choices that occurred as while WST terminology was being clarified, and also highlights underlying assumptions that became apparent as WST evolved. Even though the work system framework at the core of WST is familiar to many IS researchers, this article aspires to the second of DiMaggio's (1995) three views of good theory, that good theory is "a device of sudden enlightenment ... complex, defamiliarizing, rich in paradox .... a 'surprise machine' ... a set of categories and domain assumptions aimed at clearing away conventional notions to make room for artful and exciting insights." DiMaggio's hyperbole aside, the WST body of theory was developed with the long term goal of providing a fundamentally different way to think in depth and to communicate effectively about systems in organizations.

The glossary in Table 1 defines many terms related to work systems and work system theory that are used in this article. More thorough discussions of most of these terms (other than WST per se) appear in Alter (2006b) and/or in subsequent articles that are cited throughout this article.

This article unfolds as follows. A brief summary of the background leads to an overview of WST's components, which in turn provides the context for explaining underlying premises and assumptions and the breadth of concepts in WST. Components of WST (listed in Table 1) and the background about how and why WST was developed have been presented in substantially more depth (e.g., Alter 2003a, 2006b, 2008a, 2008b, 2010a, 2010d; Truex et al., 2010). The discussion of underlying premises and assumptions highlights differences from commonly used terminology, frameworks, and beliefs in the IS field. A new concept classification matrix illustrates the breadth of concepts that are included in this body of theory. Possible extensions of WST are discussed, including the possibility that it might serve as a focal point for developing a body of knowledge for the IS field. The Appendix illustrates some of the possibilities for further development by listing 21 research projects that could extend the WST body of theory in a variety of directions.

WST was developed with the conscious goal of incorporating ideas and methods associated with a broad range of disciplines and approaches including general systems theory, systems analysis and design, organization theory, information theory, total quality management, operations management, marketing theory, and computer science. Given its length limitations, this paper does not explain direct and indirect relationships between some of the ideas in the WST and a variety of ideas that are associated with each of those disciplines. A useful coverage of that material would be longer than the current article, and would leave no room for the achieving this article's purpose of presenting WST as a body of theory, visualizing it in relation to ideas about theories in general, and identifying areas in which it might develop further.

Table 1. Glossary of Central Terms in Work System Theory
These terms are listed with the most central terms first and additional or peripheral terms later.
Work system theory (WST). A body of theory for analysis, explanation, prediction, and design and action related to systems in organizations.
Work. The application of resources such as people, equipment, time, effort, and money to generate products and services for internal or external customers
Work system. A system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal or external customers.
Information systems as a special case of work systems. Information systems are work systems whose processes and activities are totally devoted to processing information. (Alter, 2006b,

2008a)

Work system method (WSM). A flexible systems analysis and design method for business professionals; based on viewing systems in organizations as work systems. (Alter, 2006b, 2008a); Truex et al. 2010)

Work system framework. Visual representation of a static view of a work system's form and function during a particular time period; minor adaptations may occur within that configuration. Consists of nine elements that should be included within a basic understanding of the work system: customers, products and services, processes and activities, participants, information, technologies, environment, infrastructure, strategies. (Alter, 2006b, 2008a, 2008b, 2010a)

Work system snapshot. A one-page summary of a specific work system in terms of six elements: customers, products and services, processes and activities, participants, information, technologies. (Alter, 2006b, 2008a, 2008b, 2010d)

Work system life cycle model (WSLC). A dynamic view of how work systems change over time through iterations that may combine planned and unplanned change. Phases include operation and maintenance, initiation, development, and implementation. (Alter, 2006b, 2008a, 2008b, 2010d)

Work system principles. A set of principles that should apply to the elements of any work system and to the work system as a whole; currently includes 24 principles. (Alter, 2004; Alter and Wright, 2010)

Design spaces for work systems. Organized summaries of different types of work system changes and implied directions for change that might be considered during the analysis and design of work systems. One design space identifies types of changes in components and form for each element; another identifies characteristics that might change; others involve metrics, risks and obstacles, work system principles, and different locations in which knowledge can be located (Alter, 2006b, 2010b).

Metamodel for integrated analysis and design of sociotechnical and technical systems. A more highly elaborated version of the work system framework, designed to support detailed analysis and design of technical and sociotechnical systems more effectively than the work system framework, whose goal is to support basic understanding and summary-level communication about specific systems in organizations. (Alter, 2010a)

Service value chain framework. Core of an extension of WST related specifically to performing services; represents value co-creation in relation to responsibilities of service providers and service consumers along a series of typical categories of service activities; can be used in conjunction with the work system framework. (Alter, 2008b, 2010d)

System interaction theory. Theory for analysis that identifies different types of work system interactions; also includes several testable propositions related to congruence and alignment of interacting work systems. (Alter, 2010c)

Model of information system risk. Posed in relation to a specific work system, this model includes goals and expectations, risk factors and other sources of uncertainty, the contingency management effort, the range of outcomes and their probabilities, impacts on other work systems, and resulting financial gains or losses. (Alter and Sherer, 2004)

Background about Work System Theory

WST's evolution to date stems from a project extending over two decades in which Alter tried to develop a systems analysis method that can be used by business professionals for their own understanding and can support communication between business and IT professionals. That research effort anticipated many of the goals of design science research (Hevner et al., 2004; Winter, 2008), such as relevance, testing, and iterative improvement. For example, Alter believed that the problem was relevant based on his experience in a manufacturing software firm in the 1980s and based on subsequent reports by his Executive MBA students that, unlike well-trained IT professionals, most business professionals in their firms were not aware of well articulated analysis methods that they could use for thinking about systems and system improvement. Work system concepts and methods were developed through numerous iterations. The initial ideas were an attempt to distill, combine, and simplify industry experience plus ideas from many sources including the sociotechnical literature (e.g. Cherns, 1976; Bostrom and Heinen 1977a, 1977b; Mumford and Weir, 1979; Trist, 1981; Pasmore, 1985; Majchrzak and Gasser, 2000; Majchrzak and Borys, 2001, Thomas et al., 2008), systems theory (e.g., Ackoff, 1981; Checkland, 1999; Churchman, 1979), systems analysis textbooks, total quality management, and Six Sigma. Over many years, MBA and Executive MBA students used successive versions of a work system analysis outline to write group papers analyzing IT-reliant work systems in their own organizations. The papers from each semester revealed confusions, knowledge gaps, and other problems that led to revisions in the work system analysis outlines for subsequent semesters. For example, Alter (2006a) identifies pitfalls observed in 202 group papers between 1997 and 2002 and approaches that were attempted for minimizing those pitfalls. The work system method that evolved over time is basically a set of ideas that can be classified as a theory for analysis and for design and action.

WST assumes that the unit of analysis is a work system, a sociotechnical system 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 that rely on IT but are not IT systems. Information systems, supply chains, and ecommerce systems are special cases of work systems. Table 2 lists a subset of 75 IT-reliant work systems that were analyzed by advanced MBA students at a major East Coast US university who looked at work systems in their own organizations for class projects in spring 2009. As reported in Truex et al. (2010), the deliverable was a five part management report (executive summary, background, system and problem, analysis, recommendation and justification) written based on a work system analysis template that included tables for summarizing the "as is" work system, assessing how well it operates and where problems exist, summarizing a proposed "to be" work system, and clarifying why proposed changes probably would improve performance.

Table 2. Examples of work systems analyzed by employed MBA students

• Renewing insurance policies • Receiving materials at a large warehouse • Controlling marketing expenses • Performing pre-employment background checks • Performing financial planning for wealthy individuals • Approving real estate loan applications •	• Planning and dispatching trucking services • Scheduling and tracking health service appointments • Operating an engineering call center • Administering grant budgets • Collection and reporting of sales data for a wholesaler • Invoicing for construction work • Determining performance-based pay • Timekeeping for field technicians for a public utility	• Finding and serving clients of a marketing consulting firm • Determining government incentives for providing employee training • Planning for outages in key real time information systems • Acknowledging gifts at a high profile charitable organization • Acquiring clients at a professional service firm • Purchasing advertising services through an advertising agency

The work system framework and other aspects of WST have been used in North America, Europe, Asia, and Australia as a component of university courses for undergraduate business majors, undergraduate IS majors, generalist MBA students, and MBAs majoring in IS. The courses have included introduction to IS, systems analysis and design, business process improvement, IS development, and ERP systems. In some cases the usage involved one or several lectures to provide context for the course or for important topics. Some courses asked students to apply the work system framework to create "work system snapshots," which summarize a work system using the six central elements of Figure 1. The work system framework, work system principles, or sets of questions related to work system elements have been used to establish the rationale for programming projects by computer science students. The ideas have also served as the conceptual core of projects in generalist undergraduate and MBA classes (e.g., the projects mentioned in Table 2).

Beyond its use in teaching, a number of researchers other than Alter have applied or cited the work system framework and other aspects of the work system approach in a broad range of contexts. (e.g., Luukkonen et al. (2010), Granlien (2010), BenMoussa (2010), Kampath and Röglinger (2010); Petkov et al. (2010); Madsen and Vigden (2009); Gericke and Winter (2009); Ou and Banerjee (2009); Adams (2009); Lafaye (2009); Pinhanez (2009); Kosaka (2008, 2009), Lyytinen and Newman (2008), Mettler (2008); Singh and Woo (2008); Petersson (2008); Petkov and Petkova (2008); Kurpjuweit and Winter (2007); Sewchurran, and Petkov (2007); BenMoussa (2007); Goodhue (2007); Benbasat and Zmud (2006), Cuellar et al. (2006); Curtin et al. (2006); Davamanirajan et al. (2006); Gray (2006), Møller (2006), Lucas and Aggarwal (2005), Srinivasan et al. (2005); Dumas et al. (2005), Irwin and Turk (2005); Casey and Brugha (2005), Fortune and Peters (2005); Munk-Madsen (2005); Patten et al. (2005); Petrie (2004); Rowe et al. (2004); Siau et al. (2004); Walls et al. (2004); Mora et al. (2003), Nurminem (2003); Mursu (2002); Ramiller (2002); Hedman and Kalling (2002), Borrell and Hedman (2001)). Other related research is in progress.

Summary of Work System Theory

Topics in this section include the definition of work system, work system as a general case for systems in organizations, work system method, work system framework, the work system life cycle model, work system principles, design spaces for changing work system components, characteristics, and interactions, a new metamodel for integrated analysis and design of sociotechnical and technical systems, and a new concept classification matrix for organizing concepts related to work systems and special cases of work systems such as information systems. The metamodel clarifies concepts underlying the work system framework and may be a step toward developing computerized systems analysis and design tools based on WST (Alter, 2010a). The concept classification matrix may be a step toward producing a body of knowledge for the IS field.

Definition of work system. A work system is a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal or external customers. Typical business organizations contain work systems that procure materials from suppliers, produce products, deliver products to customers, find customers, create financial reports, hire employees, coordinate work across departments, and perform many other functions. Almost all significant work systems in business and governmental organizations rely on IT in order to operate efficiently and effectively.

Work system as a general case for systems in organizations. *Work system* is a general case for thinking about systems within or across organizations. There are many special cases that should inherit the body of knowledge from the general case. For example, information systems are work systems whose processes and activities are totally devoted to processing information. (Alter, 2008a) Supply chains are inter-organizational work systems whose goal is to provide supplies required for the operation of organizations that use whatever the supply chain produces. The use of an ecommerce web site can be viewed as a self-service work system. On the other hand, software such as an ERP suite is not a work system; rather, the entire suite is infrastructure shared by multiple work systems; the programs that are used in a specific work system are part of the technology within that work system. In turn, as represented in the metamodel discussed later, each of those specific programs might be viewed as a totally automated work system.

Work system method. This is a flexible systems analysis method that starts by identifying the work system that is to be created or improved. Various versions of the work system method use tools such as a "work system snapshot" to summarize the "as is" work system and the "to be" work system that will exist after any proposed changes are implemented. The MBA students who analyzed the work systems listed in Table 2 use a version of the work system method based on a work system analysis template that guided a simplified analysis process and then provided an outline of a management report. Future versions of the work system method may be supported by interactive tools based on a combination of the work system framework and the metamodel that is discussed later.

Work system framework. The work system approach contains two central frameworks. 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 a static view of a work system's 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.

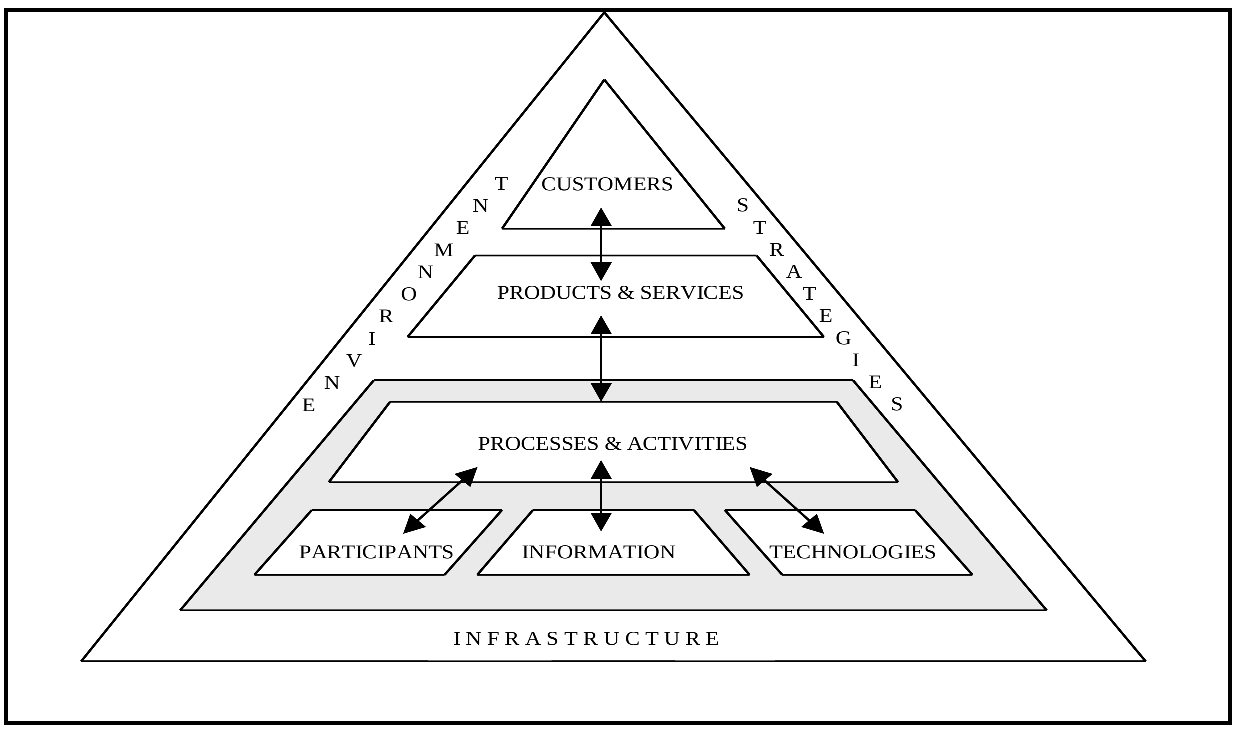

Figure 1. The Work System Framework. Alter (2008a, 2008b)

People appear in four different places in the work system framework. Customers and participants are people. Customers may or may not be participants, e.g., they are work system participants in many service situations and all self-service situations such as purchasing through ecommerce web sites. The environment includes people who carry the organizational culture, practices, history, and conflicts that influence the work system's effectiveness but may not be viewed as part of the work system. Infrastructure includes human, informational, and technical infrastructure.

Work system life cycle model. The other central framework in the work system approach is the work system life cycle model (Figure 2) which expresses a dynamic view of how work systems change over time through iterations involving planned and unplanned change. (Alter 2006b, 2008a, 2008b, 2010d). Planned change in the WSLC is represented by projects that include initiation, development, and implementation phases. Development involves creation or acquisition of resources required for implementation of desired changes in the organization. Unplanned changes, represented by inward-facing arrows, are ongoing adaptations and experimentation that change aspects of the current work system or of ongoing work system projects without separate allocation of significant project resources. For example, the inward facing arrow attached to the operation and maintenance phase is typically about small work system changes that do not require formal projects or allocation of significant resources. In some cases the inward-facing arrow for the operation and maintenance phase could also represent emergent changes in practices or goals that occur over longer periods without conscious planning. The inward-facing arrows for development and implementation phases of formal projects represent emergent changes in intentions, designs, and plans based on insights and knowledge that were not considered in the initiation phase.

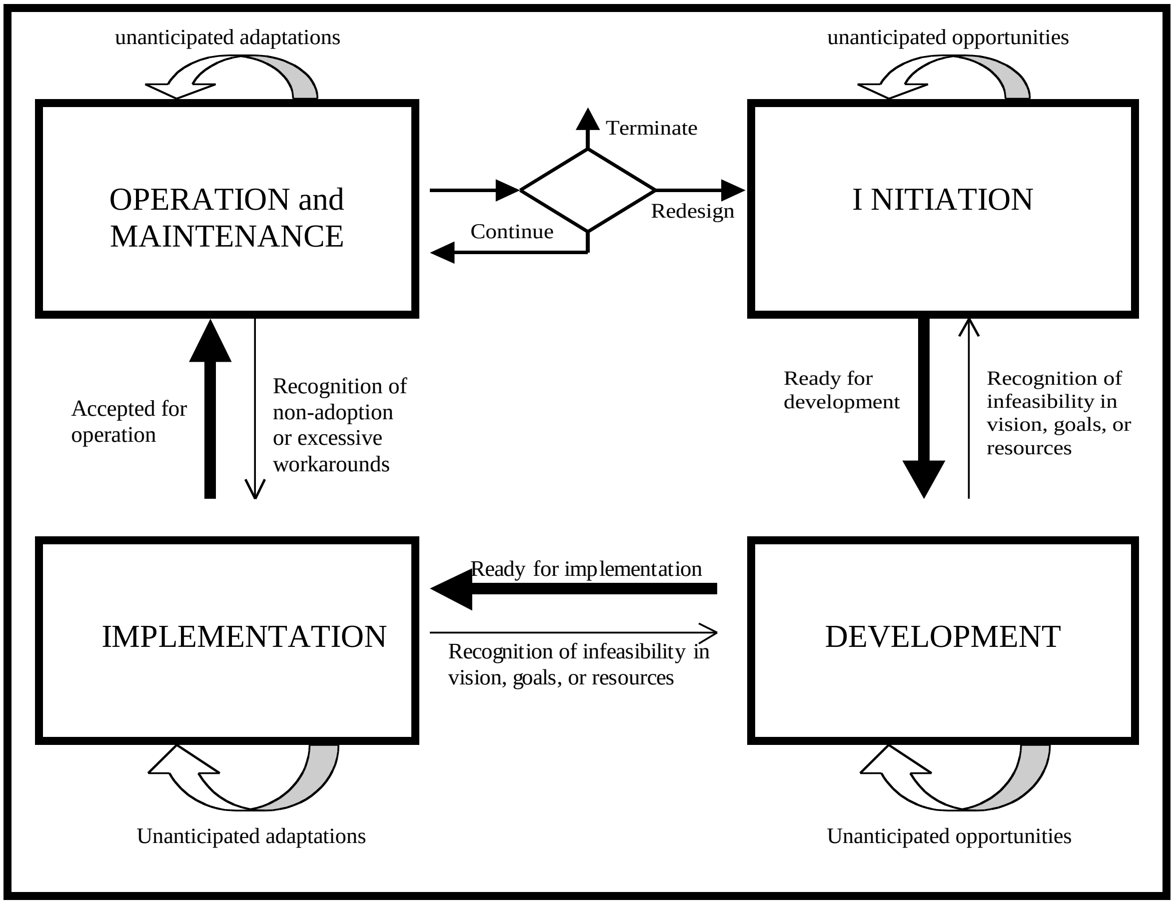

Figure 2. The Work System Life Cycle Model (Alter 2006b)

The WSLC differs fundamentally from the "system development life cycle" (SDLC). First, 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. This evolution occurs through a combination of defined projects and incremental changes resulting from small adaptations and experimentation. In contrast with control-oriented versions of the SDLC, the WSLC treats unplanned changes as part of a work system's natural evolution.

Work system principles. The idea of defining work system principles and incorporating them within the work system method was motivated by difficulties encountered by MBA and Executive MBA teams in accomplishing more than describing a work system and identifying several readily apparent weaknesses. The elements of the work system framework provided a good outline for describing a work system, but many teams had difficulty searching for improvements other than relatively obvious changes such as recording data that wasn't being recorded or sharing data that wasn't being shared. They seemed to need guidelines for thinking about the various types of improvements that might be considered. Introducing a general set of system principles seemed a plausible way to make sure that the teams would think about each element and would have a basis for comparing the current status and possible modifications to a set of ideals.

A set of work system principles were developed iteratively between 2002 and 2004 and validated subsequently based on views of Executive MBA students at the University of San Francisco between 2005 and 2009. A first version of work system principles contained one general principle per work system element. (Alter 2002c) Sociotechnical principles from Cherns (1976) were added after adapting them to make them more understandable to typical business professionals. Additional principles were added based on comments and feedback from academic colleagues and Executive MBA students. (Alter, 2004) A set of 24 work system principles listed in Table 3 seemed to strike a reasonable compromise between completeness and complexity.

<table>
<tr><th colspan="6">Table 3. 24 work system principles</th></tr>
<tr><td colspan="3">Customers</td><td colspan="3">Products & Services</td></tr>
<tr><td colspan="6">#1: Please the customers.
#2: Balance priorities of different customers.</td></tr>
<tr><td colspan="6">Processes and Activities</td></tr>
<tr><td colspan="6">#3: Match process flexibility with product variability
#4: Perform the work efficiently.
#5: Encourage appropriate use of judgment.
#6: Control problems at their source.
#7: Monitor the quality and timing of both inputs and outputs.
#8: Boundaries between steps should facilitate control.
#9: Match the work practices with the participants.</td></tr>
<tr><td colspan="2">Participants</td><td colspan="2">Information</td><td colspan="2">Technologies</td></tr>
<tr><td colspan="2">#10: Serve the participants.
#11: Align participant incentives with system goals.
#12: Operate with clear roles and responsibilities.</td><td colspan="2">#13: Provide information where it will affect action.
#14: Protect information from inappropriate use.</td><td colspan="2">#15. Use cost/effective technology.
#16: Minimize effort consumed by technology.</td></tr>
<tr><td>Infrastructure</td><td colspan="5">#17: Take full advantage of infrastructure.</td></tr>
<tr><td>Environment</td><td colspan="5">#18: Minimize unnecessary conflict with the external environment</td></tr>
<tr><td>Strategies</td><td colspan="5">#19: Support the firm’s strategy</td></tr>
<tr><td>Work System as a Whole</td><td colspan="5">#20: Maintain compatibility and coordination with other work systems.
#21: Incorporate goals, measurement, evaluation, and feedback.
#22: Minimize unnecessary risks.
#23: Maintain balance between work system elements.
#24: Maintain the ability to adapt, change, and grow.</td></tr>
</table>

As reported by Alter and Wright (2010), the 24 principles were validated by Executive MBA students, who averaged over 10 years of business experience and therefore were reasonable proxies for business professionals. Between 2005 and 2009 six cohorts rated each of the principles for "correctness," the extent to which they believed that most work systems in their organizations should conform to the principle, and "conformance," the extent to which they believed that most work systems in their organizations actually did conform to the principle. The average correctness scores between 5.3 and 6.3, with a global average of 5.9 demonstrate that as a group the respondents believe that the work system principles should apply to most systems in organizations. The average conformance scores between 3.8 and 5.0, with a global average of 4.2 out of 7.0 show that conformance to many work system principles is disappointing. The difference between correctness and conformance ratings shows that employed business professionals perceive a large gap between the guidelines provided by work system principles and the way typical work systems operate in organizations.

Concepts related to work systems. A large number of concepts that are not shown in the work system framework are related to either a work system as a whole and or specific elements of a work system. Some of those concepts are included in the two design spaces and the metamodel that are mentioned next. A subsequent section will provide a more extensive discussion of the concepts in WST.

Design spaces for work system components, characteristics, and interactions. Systems analysis and design typically focuses on identifying and improving specific components, subsystems, or interactions of systems, both at aggregated and detailed levels. Table 4 lists many types of changes that an analysis and design effort might consider. Some are in the spirit of engineering, such as adding, combining, or eliminating steps in a business process, or upgrading hardware and software. Others are more in the spirit of design, such as changing the nature of customer relationships or the customer experience. This table or some other way of expressing typical possibilities for changes in work system elements or the work system as a whole could support analysis and design efforts through general knowledge, checklists, or even design tools. Alter (2006b, 2010c).

<table>
<tr><th colspan="6">Table 4. Design space identifying possibilities for changing components, subsystems, and interactions</th></tr>
<tr><th colspan="3">Customers</th><th colspan="3">Products & Services</th></tr>
<tr><td colspan="3">• Add or eliminate customer groups.
• Change customer expectations.
• Change the nature of the customer relationship.
• Change the customer experience.</td><td colspan="3">• Change information content.
• Change physical content.
• Change service content.
• Increase or decrease customization.
• Change controllability or adaptability by the customer.
• Change customer/ participant relationships
• Provide different intangibles.
• Change by-products.</td></tr>
<tr><th colspan="6">Activities or Processes</th></tr>
<tr><td colspan="3">• Change roles and division of labor.
• Improve processes and activities by adding, combining, or eliminating steps, changing sequences, or changing methods used within steps.
• Change business rules and policies
• Eliminate built-in obstacles and delays.
• Add new functions not currently performed.</td><td colspan="3">• Improve coordination between steps.
• Improve decision making practices.
• Improve communication practices.
• Improve the processing of information (capture, transmission, retrieval, storage, manipulation, display)
• Change practices related to physical things (creation, movement, storage, modification, usage, protection)</td></tr>
<tr><th colspan="2">Participants</th><th colspan="2">Information</th><th colspan="2">Technologies</th></tr>
<tr><td colspan="2">• Change the participants.
• Provide training.
• Provide resources needed for doing work.
• Change incentives.
• Change organizational structure.
• Change the social relations within the work system.
• Change the degree of interdependence in doing work.
• Change the amount of pressure felt by participants.</td><td colspan="2">• Provide different information or codified knowledge.
• Use different rules for coding information.
• Codify currently uncodified information.
• Eliminate some information.
• Organize information so it can be used more effectively.
• Improve information quality</td><td colspan="2">• Upgrade software and/or hardware to a newer version.
• Incorporate a new type of technology.
• Reconfigure existing software and/or hardware.
• Make technology easier to use.
• Improve maintenance of software and/or hardware.
• Improve uptime of software and/or hardware.
• Reduce the cost of</td></tr>
</table>

• Assure understanding of details of tasks and use of appropriate information and knowledge. • Assure that participants understand the meaning and significance of their work.	• Make it easier to manipulate information. • Make it easier to display information effectively. • Protect information more effectively. • Provide access to knowledgeable people.	ownership of technology.
Infrastructure	• Make better use of human infrastructure. • Make better use of information infrastructure. • Make better use of technical infrastructure.	
Environment	• Improve fit with organizational policies and procedures (related to confidentiality, privacy, working conditions, worker's rights, use of company resources, etc.). • Improve fit with organizational culture. • Respond to expectations and support from external stakeholders. • Improve fit with organizational politics. • Respond to competitive pressures. • Improve conformance to regulatory requirements and industry standards.	
Strategies	• Improve alignment with the organization's strategy. • Change the work system's overall strategy. • Improve characteristics related to specific work system elements	
Work System as a Whole	• Reduce imbalances between elements. • Improve problematic relationships with other work systems. • Conform to work system principles.	

Table 5 summarizes another design space by providing an organized way to use work system elements (plus "work system as a whole") to organize design characteristics that are relevant to many work systems. Each characteristic in Table 5 is a design variable that might be assessed on a numerical scale (e.g., 1 to 5). These characteristics represent big picture choices that should be considered before determining a work system's details. Typical systems analysis and design texts for IS students say relatively little about these design characteristics, and move quickly to technical documentation of processes and information. Design characteristics that are relevant to a specific work system might be used in systems analysis and design by searching for gaps between a work system's current and desired status in relation to important characteristics (e.g., Are decisions too structured or too unstructured? Are the activities too complex or too simple? Is the work too manual or too automated?) Important gaps would provide directions for changes that could be accomplished through many combinations of tactics in the design space in Table 4.

The characteristics in Table 5 are far from exhaustive. For example, trying to apply a conscious service perspective to the design might lead one to use the service value chain framework that would suggest other characteristics, such as the relative balance of provider vs. customer responsibilities, the relative balance of front stage and back stage (Alter 2008b, 2010d) and the relative importance of service interactions.

<table>
<tr><th colspan="6">Table 5: Design space identifying characteristics for elements of a work system</th></tr>
<tr><th colspan="3">Customers</th><th colspan="3">Products & Services</th></tr>
<tr><td colspan="3">• Customer segmentation
• Treatment of customer priority
• Nature of the customer experience
• Style of interaction with the customer</td><td colspan="3">• Mix of product and service
• Product/service variability
• Mix of information and physical things
• Mix of commodity and customization
• Controllability and adaptability by customer
• Treatment of by-products</td></tr>
<tr><th colspan="6">Major Activities or Processes</th></tr>
<tr><td colspan="3">• Degree of structure
• Range of involvement
• Level of integration
• Complexity
• Variety of work
• Amount of automation</td><td colspan="3">• Rhythm
• Time pressure
• Amount of interruption
• Form of feedback and control
• Error-proneness
• Formality of exception handling</td></tr>
<tr><th colspan="2">Participants</th><th colspan="2">Information</th><th colspan="2">Technologies</th></tr>
<tr><td colspan="2">• Reliance on personal knowledge and skills
• Personal autonomy</td><td colspan="2">• Quality assurance
• Quality awareness
• Ease of use</td><td colspan="2">• Range of functionality
• Ease of use
• Ease of technical support</td></tr>
</table>

• Personal challenge • Personal growth	• Security	• Ease of maintenance
Infrastructure	• Reliance on human infrastructure • Reliance on information infrastructure • Reliance on technical infrastructure	
Environment	• Alignment with culture • Alignment with policies and procedures	
Strategies	• Fit with the organization's strategy • Fit with the strategy of related work systems	
Work System as a Whole	• Centralization/ decentralization • Capacity • Leanness • Scalability	• Resilience • Agility • Transparency

Metamodel for integrated analysis and design of sociotechnical and technical systems. Figure 3 is a representation of an integrated metamodel for the analysis and design of sociotechnical and technical systems. (Alter, 2010a). Sociotechnical concepts in the metamodel include customer and non-customer participants, actor roles, activities, environment, and human infrastructure. Technical concepts include technical and informational entities and technical and informational infrastructure. Attributes of those concepts also represent both sociotechnical and technical concerns. For example, goals, incentives, and job satisfaction are attributes that would typically appear in analysis from a sociotechnical viewpoint.

The impetus for creating the metamodel came from reading hundreds of reports by MBA and Executive MBA students about IT-reliant work systems in their own organizations. A general conclusion was that the work system framework (Figure 1) is effective for developing a summary that reflects basic understanding of a work system and for performing a preliminary analysis, but that deeper analysis would benefit from a more detailed view of most or all of the elements, something like the view in the metamodel. Earlier versions of this metamodel received a range of helpful suggestions at WITS 2009, at the 2009 JAIS Theory Development Workshop, and from discussions with conceptual modeling experts. The overall response about the metamodel's purpose, form, and content was mostly, but not unanimously positive.

Figure 3 uses shading to highlight the distinction between elements in the work system framework and other concepts that are not in the work system framework. Some terms that appear in the work system framework are defined differently in the more detailed metamodel. In general, representation decisions attempt to maximize understandability while highlighting potential omissions from an analysis or design process. To the extent possible, the representation in Figure 3 tries to place resources on the left, operational structure in the middle, and intentions on the right. 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. The use of the metamodel in analysis situations would apply those concepts as the analyst defines the problem or opportunity, evaluates the "as is" work system, and justifies proposed improvements that would appear in the "to be" work system.

Whereas the work system framework in Figure 1 is simple enough to present to typical business professionals, the metamodel in Figure 3 contains so many elements and relationships that it is best used in the background as part of a template or decision support tool that helps in selecting specific topics that need to be considered, discussed, or documented in some way. The metamodel may also be more effective than the work system framework as a means of organizing the body of knowledge in the IS field, as will be discussed later.

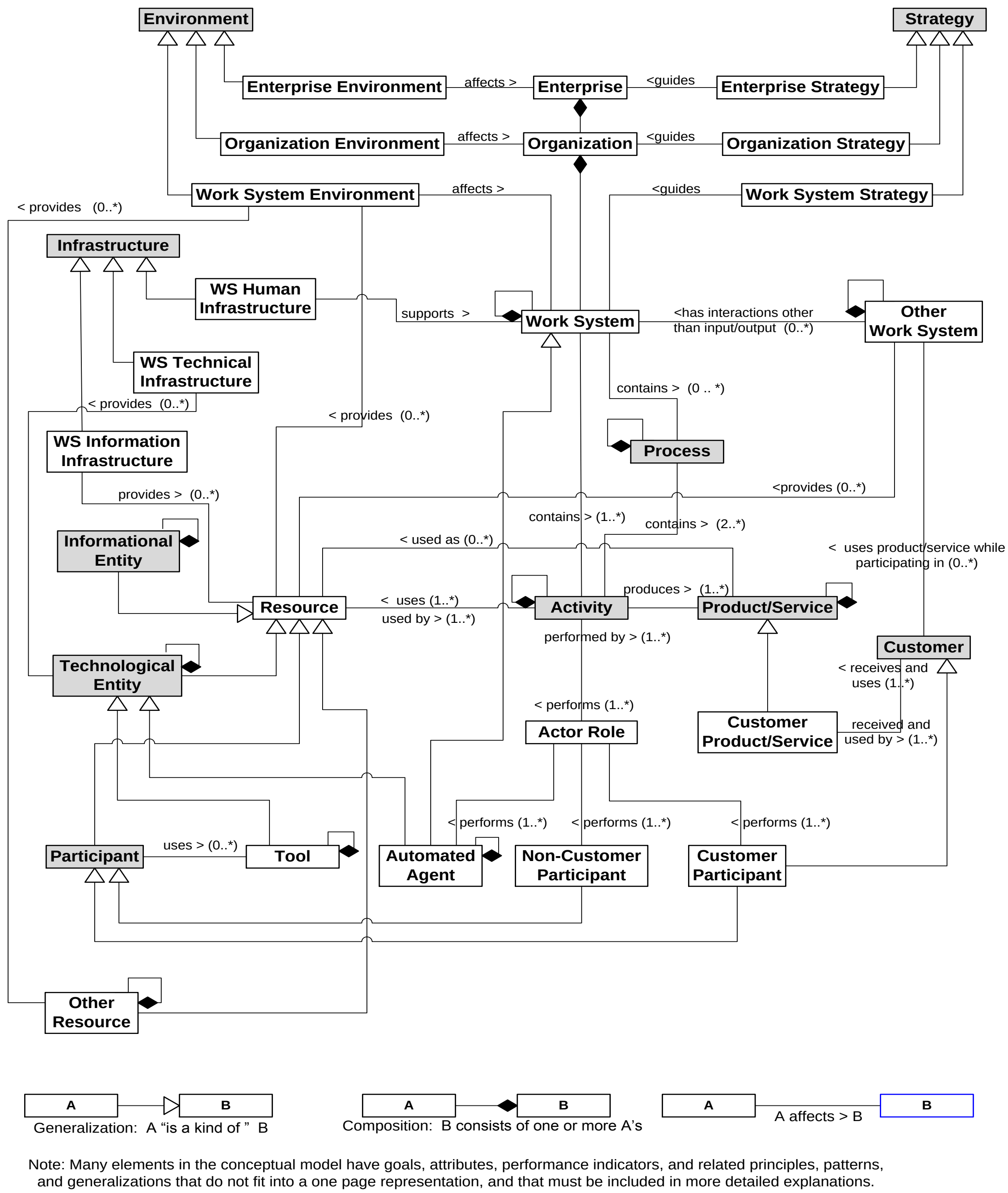

Figure 3: Metamodel for integrated analysis and design of sociotechnical and technical systems (not showing multiple goals, attributes, principles, and other important concepts related to specific elements)

Inching toward the Current Version of Work System Theory.

In a response to Sutton and Staw's (1995) article "What Theory is Not," Weick (1995) emphasizes the process of theorizing, "which consists of activities like abstracting, generalizing, relating, selecting, explaining, synthesizing, and idealizing." (p. 389) He says that most theories are approximate theory, the product of "interim struggles in which people intentionally inch toward stronger theories." (p. 385)

"Inching toward stronger theories" is a good description of the process by which WST developed over time. Most parts of WST were modified over time based on examination of hundreds of student assignments and questioning of whether the then-current version of WST provided insight about articles in newspapers and journals for business practitioners and IS academics. Some of the earlier developments are listed below, as best they can be reconstructed by looking at four editions of an information system text book (Alter 1992, 1996, 1999b, 2002a) and a series of articles that began in 1995.

- **Work system**. In the evolution of WST, the term *work system* first appeared and in Alter (1999a), a *CAIS* article called "A General, yet Useful Theory of Information Systems" in Alter (1999b), the third of four editions of an information system textbook (Alter 1992, 1996, 1999b, 2002a). Had the IS literature been available on search engines around that time, the mistaken belief that *work system* was a new concept would have been refuted quickly by looking at extensive use of that term, although with a somewhat different meaning, in the first volume of *MIS Quarterly* (Bostrom and Heinen 1977a, 1977b).

- **Work system framework**. The earliest version of the work system framework was a formatted template called a system diagram that was used for summarizing chapter-opening examples in Alter (1992). The next edition, Alter (1996), presented the *work centered analysis (WCA) framework*, a six-element framework (customer, product, business process, participants, information, technology) that had appeared previously in the proceedings of a conference on basic information system concepts (Alter 1995). The term *work system framework* first appeared in the fourth edition of the textbook, in an article in *CIO Insight*, and the first article that mentioned the work system method (Alter, 2002a, 2002b, 2002c).
- **Work system method**. The term *work system method* first appeared in 2002. Previously, the second and third editions of the IS textbook (Alter, 1996, 1999b) had presented a precursor of the work system method that was called *work-centered analysis*. Even though the term work system was not used in those books, the idea was to focus on work while thinking about an information system. Work-centered analysis treated architecture, performance, infrastructure, context, and risk as five perspectives for looking at the six elements of a system. The *work system method* first appeared in a *CAIS* article called "The Work System Method for Understanding Information Systems and Information System Research" (Alter 2002c). That article provided the first combined coverage of the work system framework, work system life cycle model, the first version of work system principles, and an early version of the work system method based on those principles. It also noted that information systems are a special case of work systems and that concepts and success factors could be inherited by special cases from general cases.

- **Work system life cycle model**. The first version of the work system life cycle model was represented as a 4-step waterfall life cycle of an information system (initiation, development, implementation, operation and maintenance) in Alter (1992), which also discussed reasons for using different approaches in the development phase. Alter (1996) retained the waterfall structure but introduced the possibility of returning to a previous phase for rework. The realization that a genuinely iterative work system life cycle model was preferable occurred while editing and expanding a case study written with Executive MBA students based on a classroom assignment (Cox et al., 2001). An iterative version was first published in Alter (2001b), although a more convenient rectangular format that facilitated insertion of various types of details first appeared in Alter (2002b) and was developed further in Alter (2006b).
- **Processes and activities**. The activities in the work system framework were originally called work practices in Alter (1992) in order to differentiate between theoretical processes in documentation vs. actual processes in practice. Alter (1996, 1999b, 2002b) used *business process* instead of *work practices* because that seemed simpler. Alter (2003a) reverted to *work practices* because that term seemed both more accurate and more general than *business process*, which implied an unrealistically limited set of situations involving a structured set of activities with a known beginning and end and a well defined transitions from step to step. The term *processes and activities* replaced *work practices* starting with Alter (2008a, 2008b) because MBA students found the term *work practices* awkward and a bit unnatural to use.
- **Products and services**. Although distinctions between products and services appeared in all four editions of the textbook, the term *product* was used in the system diagram in

Alter (1992) and in the work-centered analysis framework in the next two editions. The term *products and services* first appeared in the work system framework in Alter (2002a, 2002b, 2002c). Service concepts were extended substantially in the service value chain framework and related ideas starting with Alter (2007, 2008a, 2008b, 2010d).

- **Concepts related to work systems**. The need to clarify basic concepts about systems in organizations appeared first in Alter (2000) and soon was entwined with the observation that the basic ideas of information systems were about work systems, which appeared in Alter (2001a), "Are the Fundamental Concepts of Information Systems Mostly about Work Systems?" Both of those ideas reappeared in different guises in Alter (2003a, 2005, 2006c, 2008a, 2010d), in Sherer and Alter (2004), and in this article's discussion of the concept classification matrix. The proposed architecture of Sysperanto (Alter, 2005) proved useful in producing the first versions of a series of tables of concepts that appeared in Alter (2006b) and later were described as design spaces in Alter (2010b).

Weick's characterization of "interim struggles in which people intentionally inch toward stronger theories." is certainly borne out by the above sequences of extensions, clarifications, and name changes in basic components of WST. As that sequence unfolded, basic premises and assumptions underlying work system theory started to emerge.

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Premises and Assumptions Underlying Work System Theory

This section discusses a number of underlying premises and assumptions became evident during the evolution of WST to date. While it might be disappointing that WST was not deduced from basic premises and assumptions through logic and the accumulated wisdom in the literature, the interim struggles mentioned above show that basic premises and assumptions were not at all obvious at the outset. Consistent with arguments by DiMaggio (1995) that theories should encourage insights rather than summarizing beliefs that seem obvious, the following summary of underlying premises and assumptions emphasizes areas of divergence from typical terminology, frameworks, and beliefs in the IS field.

Scope of applicability. WST was developed to help business professionals describe, analyze, design, and evaluate work systems in organizations. It is less general than general systems theory (which also applies to biological and physical systems that are beyond the scope of WST). It is more general than a theory of how to build a website or why people decide to use technology. As a theory about work systems in general, it is also more general than a theory specifically about information systems, which are a special case of work systems.

WST is most applicable to operational business systems (see Table 1), almost all of which can be viewed as IT-reliant work systems. WST is less applicable in situations where designed patterns of purposeful activity cannot be articulated, or where technology has been distributed in experiments as a first step in a desired innovation and diffusion process. It is less applicable to situations that are better described as ecologies, rather than work systems in which various elements of the work system framework can be identified. Although it can be used to model computer programs and algorithms, approaches from computer science are more appropriate for that purpose. It can be used to model entire enterprises or organizations, but it is less useful at that level because entire enterprises and organizations involve too many people doing to many different types of work using to many different types of information technology.

- New or different: WST provides a body of theory for IS, but is stated in terms of work systems in general, perhaps conflicting with the frequently stated goal of identifying core theories that are unique to the IS discipline (e.g., Weber, 2003).

Inheritance of concepts. WST treats work system as a general case, with special cases including information system, project, and supply chain. An information system is a work system whose activities are devoted to processing information. Other important special cases include supply chain (which crosses organizations), projects (which are designed to produce a product and go out of existence) and the self-service use of ecommerce web sites. Each of the special cases should inherit most concepts, principles, and generalizations that are relevant to work systems in general, although the special cases may rename the concepts with other terms that are more directly associated with special cases.

- New or different. The hierarchy of system types, with information systems as a special case of work systems, may explain some of the difficulty of developing IS theories and a body of knowledge about information systems. It is possible that most of the body of knowledge relevant to information systems and most of the valuable theories are either about work systems in general or about special cases of information systems, and that almost nothing of genuine interest can be said about information systems in general that is not also true of work systems in general. (Alter, 2005, 2008a)
- New or different. As will be mentioned later, a body of knowledge for the IS field might be organized using a 3-dimensional concept classification matrix in which the layer for work systems in general might not be identical to the subordinate layers for information systems in general or for particular types of information systems. For example, some but

not all principles for accounting information systems in general would be principles for work systems in general. That type of organization is quite different from the organization of a body of knowledge for IS proposed by Iivari et al. (2004).

Service orientation. WST has a built-in service orientation, starting with the way in which the work system framework (Figure 1) places customers at the top, thereby emphasizing that the purpose of work system is to produce products and services for customers. Consistent with parts of the service literature that emphasize co-production of value by customers (e.g., Sampson and Froehle, 2006; Vargo and Lusch, 2004), the metamodel (Figure 3) extends the service orientation in Figure 1 by distinguishing between two types of human actor roles within a work system, non-customer participant and customer participant. That distinction is especially important when thinking about service systems, including self-service work systems such as using ecommerce web sites in which the customer is a participant who performs self-service work. Service orientation is consistent with developments in the marketing literature such as service-dominant logic (Vargo and Lusch, 2004), which has been proposed as a basic idea of "service science" (IfM and IBM, 2008; Spohrer et al., 2008).

- New or different. The IS field traditionally paid little attention to co-production of value. Emphasizing service orientation leads to the possibility of new systems analysis and design tools (Alter, 2008b) and to the possibility of seeing all systems in organizations as services. (Alter, 2010d)

Sociotechnical by default. WST assumes that human participants are usually essential elements of a work system, not just users of hardware and software. That is why work system framework

(Figure 1) contains the term *participants* rather than *users*. The default assumption in WST is that the terms system and work system usually refer to sociotechnical systems with human participants rather than hardware/software configurations that may have human users or may be hidden within computerized entities that are invisible to people who use computers and computerized information. WST also assumes that sociotechnical systems may be decomposed into successively smaller subsystems, eventually revealing hardware/software configurations that operate autonomously without the direct participation of humans. One of the reasons for developing the metamodel (Figure 3) was to be able to represent such situations more effectively in support tools for systems analysis and design that may be developed in future. Such tools would start with the default assumption that work systems are sociotechnical systems, and would be constructed to recognize that automated agents are a special case of work system in which there are no human participants, and in which the customer might be another automated agent.

- New or different. The default assumption in much of the IS field is that the term system refers to a configuration of hardware and software. With that assumption, systems are technical artifacts that users use, rather than systems in which people participate. Typical systems analysis textbooks implicitly support improving work systems, but treat "the system" as a technical artifact (a configuration of hardware and software) that is "used" by users. For example, in a summary of the design phase of the SDLC, Hoffer et al. (2008, p. 13) says "analysts must design all aspects of the system, from input and output screens to reports, databases, and computer processes." Similar statements appear in Kendall and Kendall (2008, p. 13), Dennis et al. (2002, p. 7), and Mathiassen et al. (2000, p. 7).

* New or different. The distinction between participants and users is relevant to the entire literature about "user participation" and "user involvement," especially since many stakeholders who are designated as "users" are not actually users of technology that is being built or evaluated. A reflection on Markus and Mao's (2004) review of the user participation literature argued that "project collaboration" and the work system life cycle model might be a better focal point for thinking about all those issues. (Alter, 2009).

Indeterminacy of systems with human participants. The value of producing perfect specifications of systems and software is often undermined by the variability and indeterminacy introduced by human participants. The development of WST was driven by the assumption that significant progress in systems analysis and design and related communication between business and IT professionals was possible without producing increasingly precise documentation of specifications and requirements, a typical emphasis of research concerning business process management (BPM), UML, BPMN, conceptual modeling, and ontologies. While unquestionably important for developing testable, high reliability software, the emphasis on linguistic and diagrammatic rigor usually ignores variability in human performance and possibilities that human participants will use workarounds for a variety of reasons. Recognition of the indeterminacy of systems that include human participants implies an expectation that human participants may not follow whatever specifications or requirements may have been agreed upon, may work with different degrees of accuracy and commitment at different times, and may find a variety of justifiable and/or opportunistic ways to work around whatever rigorous specifications are built into software and processes that are supposed to use the software. Workarounds and shadow systems are a major problem in certain highly controlled environments, such as pharmaceutical and semiconductor manufacturing, but may be beneficial in many other situations.

- New or different. Recognize the indeterminacy of systems with human participants and incorporate that idea explicitly into systems analysis and design, contrary to widely used and widely taught methods and notations such as UML.
- New or different. Develop a way to anticipate workarounds and shadow systems, and to integrate that understanding into systems analysis and design methods.

Design as guidelines for action rather than a strict determinant of action. The indeterminacy of systems with human participants implies that the design of most work systems cannot specify exactly what will happen inside of each non-automated step even though it can outline triggering conditions, completion conditions, and post-conditions of activities and processes.

This is one of the areas where WST might be developed further as a body of theory by incorporating ideas from research involving gray spaces and emergent phenomena. Researchers such as Suchman (1987), Schmidt and Bannon (1992), and Star and Strauss (1999) emphasize the importance of articulation work, coordination, and improvisation, topics that are downplayed in typical process models, which focus mostly on work flows, triggering conditions, resource requirements, business rules, and post-conditions of specific activities. For example, Suchman (1987) notes that plans describe what should have happened by a particular time, not exactly how things are done.

- New and different: Future development of WST could incorporate ideas from bodies of research that are often viewed as unrelated to systems analysis and design.

Multiplicity of goals. Work systems have a multiplicity of goals. Most work systems have at least several goals related to processes and activities (e.g., efficiency, consistency, and speed), human participants (e.g., output per hour, error rate, and job satisfaction), information (e.g., accuracy and completeness), technology (e.g., ease-of-use and uptime), and products and services (e.g., cost to the customer and quality perceived by the customer). This multiplicity of goals is the reason why the concept of goal does not appear in the work system framework (Figure 1) or in the metamodel (Figure 3). In both cases, goals are treated as attributes of specific elements or relationships. Like other attributes, goals are present but do not need to appear at the top of level in every diagram.

On various occasions the academic IS field as been preoccupied with the question of what is the dependent variable for information systems or information system success. The multiplicity of goals inherent in most work systems suggests that attempts to identify a single dependent variable or definition of IS success will be futile. While it is always possible to calculate a single number by constructing a mathematical combination of various metrics, the fundamental issue is that work systems have multiple goals that may not be consistent and that need to be considered separately. Managing a work system requires attention to tradeoffs between multiple goals related to different elements and their interactions.

- New and different: Recognize that multiplicity of goals related to each element of a work system. Bring the multiplicity of goals into systems analysis and design and into IS research.

Decomposition and traceability. Ideally, it should be possible to decompose sociotechnical systems into successively smaller subsystems during the course of an analysis and design effort. Conversely, it should be possible to trace the subsystems back to their supersystems, and to trace the effects of design choices in either direction. That bidirectional process should maintain attention to sociotechnical issues while also isolating hardware/software configurations that should be analyzed and designed using technical methods that are designed for IT professionals but are usually ineffective for business professionals. Capabilities for traceability across multiple levels of decomposition are available in software tools for building technical artifacts. Ideally, those same types of capabilities should be available in tools for analyzing and designing sociotechnical systems. The metamodel (Figure 3) may be a step in that direction.

- New and different. In the analysis and design of sociotechnical systems aspire to at least some of the same types of traceability that are assumed important in analysis and design of technical systems.

Layers of description. Successive decomposition of a work system into subsystems will often reveal components and phenomena that are not visible at higher levels of aggregation. For example, an administrative assistant who might not have been mentioned in a summary level description of a work system might play an important role in a subsystem, and therefore would have to be mentioned within that layer of description. Similarly for specific informational and technological entities that might be invisible in a high level summary view. One of the reasons for creating the metamodel in Figure 3 is that it should provide better support for analyzing work systems at levels more detailed than a summary level.

- New and different. Recognize the need to allow resources to become visible as subsystems are isolated during the process of decomposition in systems analysis and design.

Construction, emergence, and evolution. The work system framework (Figure 1) and the metamodel that clarifies aspects of the framework to support a deeper analysis (Figure 3) both provide a relatively static view of how a system operates at a particular point in time. The work system life cycle model (Figure 2) summarizes the process through which work systems evolve over time through a combination of planned and unplanned change.

Contrary to the form of various SDLC models in the IS literature, the work system life cycle model assumes that both planned and unplanned change occur frequently, and that deviations from an existing plan or specification are natural occurrences in many situations rather than problems that must be avoided. The work system life cycle model has been explained in substantially more detail than Figure 2 (e.g., Alter, 2006b). Concepts related to emergence and incremental change play a relatively superficial role in the current model, which might be expanded to incorporate those ideas more fully.

- New and different. Incorporate more complete views of emergence and incremental change into the work system method and work system life cycle model.

Integration with methods and concepts from other disciplines. The IS field has seen many calls for the development of concepts and theories that are uniquely associated with the IS discipline. While that may be an important issue in academic politics, it is a nonissue with regard to the goals of WST. The continuing development of WST should attempt to incorporate any genuinely useful ideas from the IS discipline and from any other discipline that is relevant to helping people analyze and design systems in organizations.

- New and different. Some IS researchers believe that the maintaining status and legitimacy in the IS field requires the development of theories that are unique to IS. Whether or not that political argument is correct, the goals of WST are best served by incorporating any genuinely useful ideas from any academic or practitioner source.

Concepts in Work System Theory

WST is an integrated, evolving body of theory consisting of assumptions, concepts, frameworks, and principles. The previous sections emphasized WST's main components and its underlying assumptions and premises. This section says more about the concepts in WST.

Desirability of a consistent, integrated set of concepts. Ideally, the concepts in any theory and in any body of knowledge should be clear, internally consistent, comprehensive, and easy to use in the theory's intended domain of application. An article called "Same Words, Different Meanings: Are Basic IS/IT Concepts our Self-Imposed Tower of Babel?" (Alter, 2000) raised these issues at the time when the work system method was initially taking shape. It showed how ten articles published in *CAIS* in 1999 used basic IS/IT terms with different meanings and connotations related to the different perspectives of their authors. The terms were system, user, stakeholder, IS project, implementation, reengineering, requirements, and solution. The article's conclusion noted that the IS field seems "terribly concerned with issues of rigor vs. relevance, as demonstrated by a 1999 issue of *MIS Quarterly* (Applegate, 1999; Benbasat and Zmud, 1999) and perennial panels on this topic at ICIS and other conferences. It is very hard to be rigorous with slippery concepts that legitimately mean different things to different people ... Does the IS discipline really have a knowledge base? Assume that this knowledge base existed in ANY form ranging from some kind of oral tradition through a highly codified database of assertions along with supporting documents. It seems reasonable to argue that a knowledge base could not exist unless the basic concepts were fairly well defined. ..."

The Tower of Babel article helped crystallize a general challenge for the development of the work system method. Regardless of whether it was impossible to get IS/IT practitioners and researchers to use basic terminology in a consistent manner, ideally it should be possible to produce at least one instance of an integrated set of basic IS/IT concepts that were internally consistent, broadly applicable across the entire IS field, and genuinely useful for understanding, analyzing, designing, and evaluating systems in organizations. (also see Alter 2006c)

Disentangling the most basic concepts.

As implied by the part of "inching along" section about the work system framework, one of the objectives of applying a fixed format repeatedly was to disentangle basic terms that are used to describe systems in organizations, for example, clarifying that a work system and a process are not the same thing. Although the elements of the work system framework may seem relatively obvious now, even now one often encounters usage of those terms that is inconsistent with definitions in the framework. For example,

- Technology as system: Configurations of hardware and software are often referred to as "the system," both in everyday speech and in systems analysis textbooks. Sometimes it is not clear whether a phrase such as "our accounting system" or "our manufacturing system" refers to software or to a system or process.

- Process as system: People often refer to processes as systems, as in "our accounting system" or "our manufacturing system."
- Processes as technology: Processes are sometimes viewed as technology, as in "the process for grinding corn is a primitive technology."
- Information as part of technology: IT professionals sometimes refer to information as part of technology, for example, speaking of the information in SAP, when they actually mean that information is defined using data definitions or other technical means and is stored using database technology. Issues with data definitions and data storage capabilities should be distinct from issues with data quality.
- Information as a component of process: The definition of a totally structured process may include a specification of the data that it uses or generates. In some situations, however, it is possible to perform essentially the same process using somewhat different information.
- Participants and non-participants as users: People who do not use the IT within a work system and even managers who do not participate in doing the work are often called users.

Table 6 provides reasons why inclusion of each element in the current work system framework is necessary for even a rudimentary understanding of a work system. Elements such as processes and activities, participants, and technologies are treated differently in the metamodel in Figure 3 in order to support deeper and more detailed analysis and design of work systems.

Table 6: Reasons for Including Each of the Elements of the Work System Framework	
Element	***Reason for inclusion in the work system framework***
Processes and Activities	Processes and activities occur within the work system to produce products and services for its customers. A work system must contain at least one activity. Otherwise it does not do anything. Use of the term "processes and activities" recognizes that the work being performed may not be a set of clearly specified steps whose beginning, sequential flow, and end are well-defined. Many important work systems perform organized 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 by some definitions.
Participants	Participants are people who perform work within the work system, including both users and non-users of IT. Not including participants in an analysis automatically omits important sources of variation in the results. Inclusion of the term participant instead of the term user avoids confusions from talking referring to stakeholders as users, whether or not they actually use the technology in a work system that is being analyzed.
Information	All work systems use or create information, which in the context of work system analysis is expressed as informational entities that are used, created, captured, transmitted, stored, retrieved, manipulated, updated, displayed, and/or deleted by processes and activities. 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. For example, an order may contain a line item and a document may contain a chapter.
Technologies	Almost all significant work systems rely on technology in order to operate. Technologies include both tools that are used by work system participants and automated agents that are hardware/software configurations that perform totally automated activities. That distinction is crucial as work systems are decomposed into successively smaller subsystems, some of which are totally automated.
Products and Services	Work systems exist in order to produce things for their customers. Ignoring what a work system produces is tantamount to ignoring its effectiveness. Products and services consist of information, physical things, and/or actions produced by a work system for the benefit and use of its customers.
Customers	Customers are recipients of a work system's products and services for purposes other than performing work activities within the work system. Since work systems exist to produce products and services for their customers, an analysis of a work system should consider who the customers are, what they want, and how they use whatever the work system produces. External customers are work system customers who are the firm's customers, whereas internal customers are work system customers who are employed by the firm, such as customers of the firm's

	payroll work system. Customers of a work system may also be participants in the work system (e.g., patients in a medical exam, students in an educational setting, and clients in a consulting engagement).
Environment	Factors in a work system's environment may have direct or indirect impacts on its performance results, aspiration levels, goals, and requirements for change. Analysis and design efforts that ignore important factors in the environment may overlook issues that degrade work system performance or even cause system failure. Environment includes the relevant organizational, cultural, competitive, technical, regulatory, and demographic environment within which the work system operates, and that affects the work system's effectiveness and efficiency. Organizational aspects of the environment include stakeholders, policies and procedures, and organizational history and politics, all of which are relevant to the analysis and design of many work systems.
Infrastructure	Infrastructure includes relevant human, information, and technical resources that are used by the work system but are managed outside of it and are shared with other work systems. Infrastructure can be subdivided into informational infrastructure, technical infrastructure, and human infrastructure, all of which can be essential to a work system's operation and therefore should be considered in any analysis of a work system.
Strategies	Strategies that are relevant to a work system include enterprise strategy, organization strategy, and work system strategy. In general, strategies at the three levels should be in alignment, and work system strategies should support organization and enterprise strategies. Unfortunately, strategies at any of the three levels may not be articulated or may be inconsistent with reality or with beliefs and understandings of important stakeholders.

The nine elements in Table 6 are certainly not the only possible choices. For example, those elements might be compared to elements of a number of other useful frameworks that were designed for somewhat related purposes but that omit some or most of these nine elements:

- input-processing-output
- people, process, technology
- Leavitt framework (1965): task, structure, people, and technology
- SIPOC: supplier, input, processing, output, customer
- CATWOE from soft systems methodology (Checkland 1999): customer, actor, transformation process, world view, owners, environment

- Activity theory: A graphical representation in Kuutti (1995) contains 7 elements: subject, object, community, tool, rules, division of labor, and outcome.
- Zachmann's enterprise architecture framework: The 6 rows include scope, business model, system model, technology model, detailed representations, and functioning enterprise. The six columns include what, how, where, who, when, why.

A detailed comparison of the areas of applicability of these frameworks and other frameworks and the advantages and disadvantages of using the work system framework to supplement or replace them (or vice versa) is beyond this article's scope.

Hundreds of other concepts.

A comprehensive body of theory about systems in organizations cannot rely solely on definitions of nine basic elements. Each element has a large number of properties that are important for analysis, explanation, prediction, and design and action.

Table 7 presents a two dimensional matrix for classifying concepts related to work systems. (An extension to three dimensions to cover special cases of work systems such as information systems will be discussed later.) The vertical dimension of the matrix consists of the work system as a whole and each of its nine elements. The horizontal dimension consists of 10 categories of properties for elements. The result is 10 by 10, i.e., 100 cells into which concepts (and principles and empirical findings) relevant to work systems can be classified. For example, the note at the bottom of Table 7 says that cell (4,2) is the location for concepts related to aspects of performance, metrics and goals related to the customer, and that cell (6,6) contains concepts concerning standards and rules related to using personal data.

Table 7: Concept Classification Matrix for Work System Theory

	1) Components and phenomena	2) Actions and methods	3) Characteristics	4) Aspects of performance, metrics, goals	5) Risks and obstacles	6) Standards and rules	7) Exceptions, workarounds, and special cases	8) Relationships and interactions	9) Principles and generalizations	10) Empirical findings
1) Work system as a whole										
2) Customer				Cell (4,2)						
3) Products and services										
4) Processes and activities										
5) Participants										
6) Information						Cell (6,6)				
7) Technologies										
8) Environment										
9) Infrastructure										
10) Strategies										
	Sample cells: .... Cell (4,2) Aspects of performance, metrics and goals related to the customer .... Cell (6,6): Standards and rules related to using personal data Note: The column for empirical findings is included to indicate where empirical findings would belong if this matrix were used to organize a body of knowledge									

The ten categories in the horizontal dimension clarify and extend parts of the architecture of "Sysperanto," a proposed model-based ontology of the IS field. (Alter, 2005). The first four categories in the concept classification matrix correspond to different parts of speech: nouns (components and phenomena), verbs (actions and methods), adjectives (characteristics), and adverbs (aspects of performance, metrics, goals). The next four represent additional types of concepts (but not necessarily different parts of speech) that are often important when analyzing and designing systems (risks and obstacles; standards and rules; exceptions, workarounds, and special cases; and relationships. The last two columns, 9) principles and generalizations and 10) empirical findings, involve applications of concepts rather than just concepts per se. They are included in the concept classification matrix mainly for the convenience of organizing topics related to concepts and making a comprehensive concept map available to analysts, designers, and researchers. Most of the properties in the first eight columns are words or phrases. The principles and generalizations in the ninth column are sentences. The empirical research findings in the tenth column are textual summaries of whatever empirical findings are deemed worthy of inclusion (an interesting decision by an individual or committee).

The potential value of the concept classification matrix is illustrated by its relationship with the work system principles in Table 3 and the design spaces in Tables 4 and 5. The work system principles are distributed across the 10 cells in the ninth column. The design space identifying possibilities for changing components, subsystems, and interactions (Table 4) is actually a formatted display of selected concepts from the 10 cells in the second column, actions and methods. Likewise, the design space identifying characteristics for elements of a work system and for the work system as a whole (Table 5) is a formatted display of selected concepts selected from the 10 cells in the third column, characteristics. In other words, the effort of populating the concept classification matrix could pay off by clarifying and facilitating use of various sets of concepts that are important in drilling down and expanding upon initial thoughts in an analysis and design effort. Notice, for instance, that Tables 4 and 5 include entries for each element of the work system framework and for the work system as a whole. Concepts related to the work system as a whole, such as capacity, leanness, scalability, and transparency might otherwise be overlooked as an analysis effort focuses on issues related to specific elements rather than the work system as a whole.

Inheritance through a hierarchy of work system types. A key component of the Sysperanto architecture proposed in 2005 is that work system is a general case, and that special cases such as information systems in general, projects in general, or supply chains in general should inherit both the nine elements for summarizing a work system and most of the concepts related to those elements. (The participant slot would be blank for totally automated work systems.) The implication is that the entries in the concept classification matrices for work systems in general would differ somewhat from those for special cases of work systems, and further that most of the concepts for work systems in general should be inherited by the special cases, thereby providing an efficient way to keep track of concepts related to different types of systems. In other words, the concept classification matrix might be viewed as a three dimensional matrix whose dimensions are:

1) the horizontal dimension: 10 different categories of properties,
2) the vertical dimension: the work system as a whole plus the nine elements of a work system,

3) the depth dimension: different layers for work systems in general and different special cases of work systems, such as totally automated work systems, information systems, projects, and supply chains.

Based on inheritance, most of the concepts in a subordinate layer would be inherited from its superordinate layer. Thus, information systems and projects would inherit most of their concepts from work systems in general; accounting information systems would inherit most of their concepts from information systems in general and SDLC projects would inherit most of their concepts from projects in general.

The formulation of the concept classification matrix for work systems is quite recent, and even a first draft of a fully populated version of the layer for work systems in general does not yet exist. It would be interesting to observe the similarities and dissimilarities in the results when qualified individuals or groups of qualified individuals separately attempted to populate the matrix for work systems in general. It would also be interesting to see how they would modify that matrix when producing a matrix for information systems in general. That exercise would test a "level-skipping conjecture " in Alter (2005), by which "most of the properties of information systems in general are inherited from work systems in general; very few additional concepts are related to information systems in general but not work systems in general; most of the additional properties of information systems are related to unique features of specific types of information systems." That conjecture might help explain why it is so difficult to generalize about information systems and why the IS field seems to lack a conceptual core. It may turn out that almost all of the useful properties and generalizations about information systems are either about work systems in general or about the various special cases of information systems. An easy way to prove the conjecture invalid is to identify a substantial number of concepts and principles that apply to information systems in general but not to work systems in general. (That test would immediately bump into questions about whether it is appropriate to define information system as a work system whose processes and activities are totally devoted to processing information (Alter, 2008a), or alternatively, to use some other definition that is more restrictive.

Applications in research and practice. The cells in the top layer of the concept classification matrix can be used to organize hundreds or thousands of concepts. If each of the cells in the matrix for work systems in general were populated with typical concepts that that are more closely associated with that cell than with any other cell, the result would be a two dimensional outline of the typical concepts, principles, generalizations, and empirical findings that are relevant for analyzing, designing, implementing, and evaluating systems in organizations. Even a partially populated version of the concept classification matrix could be valuable in a number of ways. Six possible applications of the concept classification matrix will be mentioned briefly. In each case, a fully developed discussion could be quite lengthy.

- **Guiding systems analysis and design**. Use the dimensions of the matrix as a checklist to make sure that analysis and design processes have considered whichever categories need to be considered, have done so at the appropriate level of depth, and have not overlooked topics in important cells accidentally or purposefully. For example, a reminder to consider concepts in cell (4,4) such as speed, consistency, and activity rate might make it more likely that those aspects of performance would not be overlooked

- **Observing systems analysis and design projects.** Researchers observing systems analysis and design projects could use the dimensions and the cells categories as a checklist for characterizing the content discussed in those projects and for assessing the completeness of an analysis or evaluation. Inattention to concepts within any cell may imply that important topics and concerns are being overlooked accidentally or purposefully.

- **Developing tools for systems analysis and design**. Most current tools for systems analysis and design related to IS focus on documenting processes, information, and technology in current and proposed information systems. It should be possible to develop new or improved tools that incorporate concepts that are downplayed or ignored by established methods.

- **Exploring complementarity with frameworks that might be alternatives to the work system framework**. The discussion of the work system framework mentioned a number of potential alternative frameworks that the work system framework might augment (or vice versa). The concepts in the cells in a populated concept classification matrix could help in visualizing some of the practical overlaps and areas where important ideas for analysis and design are or are not implied by the alternative frameworks..

- **Explaining limitations of UML and the need for other types of systems analysis tools**. It is possible to explore which cells in the concept classification matrix are and are not addressed by UML. For example, activity diagrams are more directly related to cell

(2,4), *actions and methods* related to *processes and activities*, although they also identify which participants or groups of participants perform particular activities. Most other UML diagrams belong in the same column. It is possible that other tools and methods that emphasize other concepts in the concept classification matrix might be very helpful in addressing issues and topics not addressed by UML.

- **Developing a body of knowledge for the IS field**. Populating at least the layer of the concept classification matrix for work systems in general would address the challenge mentioned earlier of providing a single set of basic IS/IT concepts that is genuinely consistent, broadly applicable across the entire IS field, and useful for understanding, analyzing, designing, and evaluating systems in organizations. It would also be a major step toward addressing calls for developing a body of knowledge for the IS discipline. (e.g., Hirschheim and Klein, 2003; Iivari et al., 2004; Hassan and Mathiassen, 2009). It would be interesting to observe and evaluate the differences in results from different teams trying to fill in the body of knowledge using that type of method.

Is the granularity of the vertical column sufficient? The reasons for creating the metamodel (Figure 3) provide an admonition about the 10 by 10 form of the concept classification matrix. It may turn out that the work system framework is not granular enough to support effective development of the body of knowledge. The concept classification matrix might be more effective if its vertical dimension used at least a major subset of the entities and relationships in the metamodel instead of the elements of the work system framework. For example, research findings concerning the technology acceptance model (TAM) do not link directly with any particular element of the work system framework, but do link directly with the relationship between *participant* and *tool* in the lower left-hand corner of Figure 3. Similarly, results to date of an attempt to develop system interaction theory (Alter, 2010c) would be attached to the link between *work system* and *other work system* on the right side of Figure 3.

Evaluation of Work System Theory as a Body of Theory

The original, highly iterative efforts in developing the work system approach paid little attention to issues related to theory *per se* or to theoretical underpinnings. The basic goal was to develop a systems analysis method that typical business people could use on their own or in conjunction with consultants, and that would help them communicate and collaborate more effectively with both the business peers and IT professionals. Regardless of the source discipline, ideas that seemed to be useful were incorporated and tested informally.

A full evaluation of WST as a body of theory should address questions related to exactly what WST is and what WST usage means, what types of theories WST contains, what special viewpoints or insights it brings, and in what ways is it useful, especially in comparison with other methods.

Exactly what is WST and WST Usage?

The set of assumptions, concepts, frameworks, and principles resulting from WST's iterative development is best described as a body of theory (Gregor, 2006, pp. 611 and 629) that includes the definition of work system, the work system framework, work system life cycle model, work system principles, and other components. Given that it is a multi-faceted body of theory that continues to evolve, it is difficult to say when WST achieved sufficient heft and breadth to be viewed as a body of theory rather than just a theory for analysis (Gregor, 2006) in the form of a framework for thinking about systems.

Unlike a compact theory for explanation and prediction that expresses a relationship between several variables, it is possible to use parts of WST without using other parts of it. The minimum level of WST usage involves using the work system framework or a work system snapshot to summarize a work system. That type of usage is relatively easy to teach and learn. Its immediate benefit is a reminder that a system in an organization is more than hardware and software, that it needs to produce something for customers, and that it relies on human participants and information in addition to technology. Slightly deeper use considers metrics for at least several of the elements, including recognition that the customer's metrics for evaluating products and services are usually different from internal metrics related to processes and activities, participants, information, and technologies.

In an example of more extensive use of WST, the 75 MBA students who used a work system analysis template when analyzing systems identified in Table 1 (Truex et al., 2010) knew about the definition of work system and work system framework but did not know about the work system life cycle model, work system principles, or the new metamodel, none of which had been mentioned in their coursework. Although their results met and often exceeded expectations for their assignment and for the amount of time that was allocated to it, knowledge of other facets of WST and more time and effort in applying the full scope of WST probably would have resulted in more insightful results. An interesting aspect of the findings was that some of these quickly written analysis reports (only 15% of the grade) seemed to capture many essential issues about the work systems they covered even though they may have included confusions about situational specifics that would have taken more time to clarify.

Questions about the meaning of WST usage are quite similar to questions about the usage of almost any highly flexible method or tool. (e.g., Truex et al., 2000) For example, research about the usage and limitations of UML and BPMN have found that both of these modeling languages are used selectively and that many capabilities of each language are not used in most specific applications of UML and BPMN. (Siau et al. 2005, Dobing and Parsons (2006, 2008), zur Muehlen and Recker 2008, Recker et al. 2009, Recker 2010). For example, assume that an IS project uses use cases and activity diagrams but does not use other UML diagrams. That degree of usage employs valuable, widely used tools, but may totally bypass the purported benefits of UML's object orientation. Under those circumstances one may question whether the essence of UML is actually being used. Similar questions might be asked about whether an attempt to produce a rich picture is tantamount to using soft system methodology (Checkland 1999), or whether drawing a picture with boundaries, inputs, outputs, some type of transformation, and possibly some type of controller qualifies as using general systems theory in a meaningful way

Types of Theory Included in WST

Gregor (2006) identifies five types of theory in the IS field. Before looking at questions about WST's value, we will look at how well WST fits Gregor's view of structural components of theories and of different types of theories in IS.

Structural components of WST. Table 8 describes the WST body of theory in terms of a set of theory components that were used in Gregor (2006) to summarize one IS theory of each of five types. Table 8 shows that WST contains the types of components that are found in most theories. In addition, some of its facets fit into each of the five categories of theory proposed by Gregor (2006):

Table 8: Structural components of WST using a template from Gregor (2006)

Theory Overview: Work system theory is broadly applicable body of assumptions, concepts, frameworks, concepts, and principles that can be used for identifying, summarizing, analyzing, designing, and evaluating systems in organizations. It is designed to help business professionals understand and communicate about such systems, with or without the help of consultants and IT professionals.	
Theory Component	***Instantiation***
Means of representation	Words, diagrams, tables.
Primary constructs	• Elements of a work system, identified by the work system framework (Figure 1) • Phases of the work system life cycle model, which describes how work systems change over time. (Figure 2) • Elements and relationships in the metamodel, which clarify some of ambiguities in the work system framework that are acceptable at the summary level of understanding but need to be clarified to support deeper levels of analysis. (Figure 3) • Concepts related to each of the elements, each of the phases, and work systems as a whole (can be organized using Table 8).
Statements of relationship	• The arrows in the work system framework (Figure 1) express the importance of alignment between the various elements in the framework. • The arrows in the work system life cycle model (Figure 2) express relationships between phases, including the possibility that changes may occur within any phase (the inward facing arrows.) • The relationships between elements in the metamodel (Figure 3) indicate the most direct paths through which various elements of the metamodel affect each other during the operation of work system.
Scope	• WST is designed to be applicable to any system in an organization or between organizations, regardless of whether that system is large or small, manual or automated, internally directed or customer facing. • Although WST can be applied to entire enterprises or to tiny repetitive processes, its area of usefulness is specific work systems that produce

	specific products and services within a larger enterprise.
Causal explanations	• Causal explanations are implied by the structure of the main frameworks. For example, the link between information and processes and activities in the work system framework (Figure 1) implies that inadequate information may degrade process performance or may cause process failure. The relationships in the metamodel (Figure 3) provide a more detailed outline that can be used in causal explanations.
Testable propositions	• WST does not contain testable propositions, although many testable propositions are implied rather directly, such as: • Among projects designed to improve the operation of specific work systems, those that are managed as work system improvement projects tend to be more successful than such projects that are managed as hardware/software projects. • In projects involving application software (whether developed or purchased), greater attention to the details of how the software will improve the performance a specific work systems will lead to a higher probability of successful results, including less painful implementation processes.
Prescriptive statements	• The most fundamental prescriptive statement is that business professionals thinking about systems in organizations should think about them as work systems (which by default are sociotechnical) rather than as software, IT artifacts, or any other entity that does not contain human participants. Further consideration of a specific work system may reveal that it is automated, however. • The 24 work system principles in Table 3 are examples of prescriptive statements about work systems that are part of WST. People who are creating or evaluating work systems can use these principles as a checklist to guide design decisions. • The design spaces in Tables 4 and 5 identify possibilities for change and important characteristics that should be considered during the process of analyzing and designing the work system. • The various versions of a work system analysis template that have been used by MBA and Executive MBA students can all be viewed as prescriptive statements about how to use WST ideas to analyze a system in an organization.

Theory for analysis. The work system framework, work system snapshot, and other analytical tools within WST have been used hundreds of times in by MBA and Executive MBA students for describing and analyzing existing or proposed systems in organizations. In such usage, the frameworks identify elements that should be considered in even a basic understanding of a work system's operation or life cycle.

Theory for explanation. Aspects of WST can be used to explain what happened in case studies such as stories related to system or project success or failure. In many cases, quick consideration of the work system framework and/or the work system life cycle model help in clarifying which type of situational features are included in an account and which are downplayed or ignored. For example, straightforward application of the work system framework may show that an IS case emphasizes the features and purported benefits of a hardware/ software configuration, but says little about how those tools actually affect business processes, work system performance, work system participants, and the products and services produced by the work system that was being supported.

In a broader sense, the concepts and frameworks in WST are rich enough to help in presenting a story about how a work system evolved to its current state, how it currently operates, what are its current challenges and issues, and how it might be improved. As noted by Ramiller and Pentland (2009) stories that address those topics may be more useful and compelling to business professionals than abstract relationships between variables.

Theory for prediction. Aspects of WST such as propositions, processes, and normative principles based on the work system framework and work system life cycle model can be used to identify factors that tend to increase or decrease the probability of success in specific situations. The following propositions come directly from specific facets of WST:

- From the work system framework: Work ystems whose elements are aligned tend to operate more efficiently and effectively than work systems whose elements are not aligned.
- From the work system life cycle model: Projects aimed at creating or improving information systems in organizations (not just software projects) tend to encounter fewer implementation difficulties if they are conceived and managed as work system improvement projects rather than as IT projects that produce and install software.
- From work system principles: Implementations of new or improved work systems tend to encounter less resistance if the new or improved work system conforms more fully to work system principles.
- From system interaction theory: Greater alignment between two work systems increases the effectiveness and efficiency of designed interactions between them. Also, greater congruence between two work systems decreases the difficulty of resolving the effects of unplanned or accidental interactions that are viewed as problems. (According to Alter (2010c), interacting work systems A and B are more highly aligned if their primary goals are more highly aligned with the goals of work system C, which is a superset of both. Congruence of work systems A and B is the degree of similarity of form, logic, and details in corresponding elements of A and B.)

Theory for explanation and prediction. The above propositions for prediction can be used for explanation as well.

Theory for design and action. WST provides frameworks and methods that were developed specifically for design and action since the overarching goal of WST is to help business professionals think about systems for themselves, with or without the help of IT professionals and consultants. The work system analysis template used to analyze the work systems in Table 1 and to propose improvements included a work system snapshot of the "as is" and "to be" work system and a tabular method for justifying any proposed changes. That template was designed for use in a highly time-constrained classroom setting. More extensive use of WST could apply many other analysis tools based on the work system principles and design spaces in Tables 3, 4, and 5, the metamodel in Figure 3, concept classification matrix in Table 7, the service value chain framework (Alter, 2008b, 2010d), and other aspects of WST.

Special Viewpoints or Insights that WST Brings

The earlier section on assumptions and premises identified a number of areas in which WST provides viewpoints or insights that are inconsistent with widely used ideas and beliefs in the IS field, and therefore may shed some light on directions in which the IS field might move. The following set of conjectures summarizes unique aspects of those assumptions and premises:

- **Type of system that analysis and design should focus on:** Analysis and design should focus on IT-reliant work systems within which applications of hardware and software occur. Although emphasizing "the IT artifact," Srinivasan et al. (2005) take a step in this direction by saying "Organizations are themselves designed artifacts within which IT artifacts are implemented and used by people. Researchers must recognize the interdependencies among organizational design, IT artifact design, and the capabilities and limitations of the people for whom these artifacts are intended."

- **Basis of knowledge about information systems**: Work system is the general case. Most of the knowledge is about work systems. It is possible that most of the rest of the knowledge is about special cases other than *information system in general*.
- **Core of the IS field**: The IS field is really about IT-reliant work systems, not just IT artifacts that are configurations of hardware and software. (Alter, 2003a)
- **Quest for unique IS/IT theories**: We may be able to find such theories, but most of them will be subordinate to a body of theory about work systems in general because most of the basic knowledge is about work systems in general.
- **Nature of IS projects**: These are work system projects in which some of the changes are related to the configuration or use of information technology. (Alter, 2006a, 2008a, 2010d). A related expectation is that IS projects that are managed as work system projects will encounter less resistance and fewer surprises than IS projects managed as the creation and installation of IT artifacts.
- **Fundamental ideas about specific types of information systems**. These are mostly equivalent to fundamental ideas about work systems in general. Along these lines, Sherer and Alter (2004) conclude that more than half of the IS risk factors in their sample from the IS risk literature are actually risk factors for work systems in general. From that perspective, the reasons why DSS and DSS projects do or do not succeed are quite similar to the reasons why CAD systems and CAD projects do or do not succeed. Most of those reasons are about the work systems that use, contain, or are modified by DSS or CAD. Like most work system change projects, DSS projects and CAD projects tend to

encounter trouble when management support is insufficient, staffing is insufficient, knowledge is insufficient, reasons for changes are not articulated, and so on.

Usefulness of WST

To date, most of the usage of WST has occurred in classroom settings. While many employed students probably have continued using aspects of WST, currently there are no detailed case studies of its use in industry. Production of case studies or other evidence of WST's usefulness in practice is an important next step for WST.

Lacking extensive real world usage to date, one way to gauge the potential usefulness of WST is through comparison of its content with the content of other alternative theories and related methods. Unfortunately, fundamental limitations apply to any comparative evaluation of WST with selected facets of UML, BPMN, soft system methodology, or other approaches. The clarity, breadth of usefulness, or other characteristics of any subset of WST compared to the same characteristics of possible alternative approaches such as activity theory, actor-network theory, adaptive structuration theory, soft system methodology, Six Sigma, the Rational Unified Process, and the Zachman framework. In each case, it would be apparent that the other approaches address different issues, and that it would be difficult to decide exactly which test cases and which versions of WST and the other approaches to use for the comparison. For example, as of 2008 the Zachman framework had evolved through 13 iterations since it was introduced in 1984 (Zachman, 2009). Despite that important limitation, a careful analysis of differences and their logical implications might help in developing WST further and might generate other valuable results..

Conclusion

This article has summarized WST as a body of theory primarily for analysis and design and action, but with facets that can be used for explanation and prediction. WST starts with the definition of work system and uses that definition as the basis of a somewhat elaborate assemblage of assumptions, concepts, frameworks, principles, and work system analysis and design templates. Some of the underlying assumptions and viewpoints in WST differ in interesting ways from common assumptions and viewpoints in the IS field. The effective use of work system analysis and design templates by many MBA and Executive MBA students demonstrates that WST is a body of theory for analysis and for design and action. The ability to use facets of WST for explanation and prediction demonstrate additional aspects of its potential value. Different parts of WST can be used selectively and at different levels of detail. Users who have been exposed to only parts of WST can still use it beneficially even though they will omit or ignore many points that might lead to a deeper understanding of a particular work system. WST has evolved through a combination of adding new components and clarifying and improving existing components. It continues to evolve.

The fundamental differences between a body of theory and a traditional theory of any of Gregor's five types makes it difficult to compare WST and traditional theories whose constructs and scope focus on narrower phenomena. Given the purposes of WST, the more valuable questions concern the extent to which WST is an contribution to knowledge, the possibility that it might augment or be augmented by other theories or bodies of theory, the possibility that it might be too complex or too simple, and the possible directions for future research that are implied by its current state of evolution.

Is WST a contribution to knowledge?

At least parts of WST have been a contribution to knowledge. The work system framework and various versions of the work system method have appeared in textbooks, have been used in a variety of educational settings, and have been cited in non-perfunctory, non-ritualistic ways by a number of researchers (as mentioned earlier).

This article's main contribution to knowledge is its explanation of WST as an integrated and evolving body of theory that extends far beyond the term work system or the relatively familiar work system framework. Leading researchers continue publishing articles about the unsatisfying state of IS theory, of the body of knowledge in IS, and of the impact of IS research (e.g., Watson 2001; Weber 2003; Hirschheim and Klein (2003), Iivari et al. (2004), Lyytinen and King (2004), Srinivasan et al. (2005), Grover et al. (2008)) Attention to the theoretical and practical strengths and weakness of WST could help researchers think about what they really want from IS theory and could also help them see directions for improving or extending IS theories that might or might not be directly related to WST.

At minimum, WST is a step in a number of the directions suggested by Hirschheim and Klein (2003) in their article "Crisis in the IS Field? A Critical Reflection on the State of the

Discipline." Even if WST does not provide either the form or the content that Hirschheim and Klein intended, attention to its potential value and of its shortcomings could help move the discourse forward. Table 9 identifies features of WST that are consistent with major suggestions by Hirschheim and Klein.

Table 9: How WST Addresses Suggestions by Hirschheim and Klein (2003)	
Relevant aspect of WST	**Related suggestion by Hirschheim and Klein (2003)**
An overarching view of systems in organizations. WST provides an overarching view of systems in organizations by focusing on work systems in general and viewing specific types of systems as special cases that should inherit most concepts and principles. WST's hierarchy of special cases, starting from viewing information systems and projects as special cases of work systems, addresses an important aspect of generalization by providing a structure for understanding where concepts and principles fit best. In a specific example, Sherer and Alter (2004) looks at IS risk factors in 46 previous articles in the risk literature and concluded that over half of them (134 of 228) were actually work system risk factors, not just IS risk factors.	"Generality: the unsolved challenge" (p. 256) " It appears that the generalization deficit is a concern that affects interpretivists and positivists alike, yet is largely ignored by both. ... We propose that this deficit could be addressed by a change in paper reviewing practices in the direction of giving generalization the same weight as methodological rigor." (p. 257) "In order to establish the broader meanings of specialized research results, it should be possible, perhaps, to generalize very specific findings from time to time across more than one specialized research contribution, even if the generalization is based on 'insufficient' evidence. ... Generalization is inherently very difficult: it requires a creative, intellectual leap to see the general behind the specific." (p. 272) "Broaden how we conceive of generalizations. (p. 279).
A shared language for describing and analyzing systems in organizations. WST provides the possibility of a shared language and a way to structure a body of knowledge. One of the explicit goals in developing the work system method was to produce at least one instance of an integrated set of basic IS/IT concepts that were internally consistent, broadly applicable across the entire IS field,	"We note the need for a shared language. Without such a language, it is difficult to arrive at a consensual core body of knowledge or even to begin framing the issue of coding such a shared BoK for the discipline as a whole. Categorization schemes that make up the subject areas of IS (*cf*. Barki *et al*. 1988; Bacon and Fitzgerald 2001) are a useful start for developing a shared language for the field,

and genuinely useful for understanding, analyzing, designing, and evaluating systems in organizations.	but have not led to a discussion on how IS knowledge as a whole should be structured." (p. 244)
Broad body of theory. Because it is based on the work system framework and includes assumptions about inheritance of properties by special cases, the scope of WST includes theory about work systems in general, theory about special cases of work systems, and theories about each of the elements of a work system.	"Move from middle-range hypotheses or conjectures to the building of broad theories that span multiple systems of hypotheses or conjectures as building blocks." (p. 279, also pp. 272-273)
Body of knowledge for IS. The concept classification matrix in Table 7 could support initial steps in organizing the proposed body of knowledge. It organizes concepts related to work systems in general. Information systems that are being created or improved are a special case. Since projects are also a special case of work system, additional knowledge related to projects in general and related to specific types of projects could be organized in the same manner. Thus, WST could contribute to a BoK effort by making it easier to identify what knowledge is present or missing, and by providing an organized way of locating new knowledge.	"Develop a discipline wide core BoK. ... Engage the conceptual, epistemic and practical issues of specifying a core body of knowledge that is widely shared." (p. 279) "To address this [Tower of Babel] issue we need a rallying point across all IS sub-specialties, something that all feel is important to strive for. ... We propose that a discipline wide focus on a properly structured, core body of knowledge (BoK) could provide this rallying point. Moreover, a broad base discussion on what to include and how to structure and code such a BoK would create the key terms of a shared, continuously extended language as well. (p. 262)
Synthesis across academic sub-communities. WST's focus on systems in organizations and its link between big picture frameworks for work systems in general and more specific concepts for work systems or special cases provide a place for concepts and principles that emerge from different sub-communities. Thus, the WST body of theory encourages synthesis across academic sub-communities. WST uses straightforward but well-defined terminology within a very general set of concepts related to systems in organizations. The concepts in WST can be used to place jargon in a broader context.	Mitigate "the current situation we seem to have an overabundance of specialty papers for in-group members with the result that the IS community as a whole suffers from serious communication gaps." (p. 277) Serve "the purpose of arriving at expanded categories of knowledge that can communicate across the narrow boundaries of our preferred academic sub-communities. .... provide some visible vehicles ... for broad syntheses that are interesting and comprehensible to all members of the IS community. (p. 277) "Translate specific jargons into more widely understood terms." (p. 279)

Could WST be augmented by other theories or bodies of theory (or vice versa)?

The obvious answer to this question is yes. WST's evolution to date was based on the assumption that it is desirable to incorporate whatever concepts and principles might contribute to its primary goal of supporting analysis and design and action.

The author is not aware of any other theories or bodies of theory that attempt to address the combination of situations, issues and audiences that WST addresses. Important approaches that come to mind immediately, such as general systems theory, Six Sigma, soft system methodology, and activity theory, to name a few. All of these approaches overlap with WST in some ways and but not others. One of many next steps in developing WST could involve more detailed comparisons whose main goal would be the identification of ways to improve WST and/or to extend the other approaches. Several such projects are mentioned in the Appendix in a list of many possible next steps. Performing formal, publishable comparisons of WST with the other approaches could be difficult, however, because each of them has many components and complexities that are difficult to pin down because they have been interpreted differently by different authors as they evolved over time.

Is WST too complex or too simple?

Theories and, by implication, bodies of theory, should be as simple as possible, but not simpler than that. The complexity of a body of theory should be evaluated in relation to the nature of the problems and issues that are being addressed. While the WST body of theory may seem to be complex in relation to most theories that appear in IS journals, and may seem to be growing more complex, it is not obvious whether it is too complex or too simple. For example, some widely used bodies of theory in physical and biological sciences and mathematics are far more complex; on the other hand, some widely used theories are simple.

WST in its current form may be too simple to accomplish all of its goals even though it may seem to have a lot of moving parts. As an example, consider a hypothetical body of theory that a nurse-practitioner might use in evaluating and treating a patient in the 15 minutes that might be available in a session. While it might possible to outline a generic problem solving process, the hypothetical body of theory's specifics concerning what to examine, what to ask, and how to interpret that information are based on knowledge that is conveyed in several years of intensive training. Even introductory books about biology, physiology, pharmacology, and psychology contain many far more frameworks and concepts than WST contains, and still need to be mastered at a reasonable level in order to do a competent job. Is there is any reason why a body of theory for analysis, design, and action in the IS discipline should necessarily be much simpler than a body of theory for analysis, design, and action in a discipline such as nursing?

A specific example within the development of WST is the question of whether the work system framework is too simple for detailed aspects of analysis and design even though it is very useful for summarization. That question was one of the motivating factors in trying to develop the metamodel in Figure 3. The metamodel appears complex because it contains many entity types and relationships. It probably is too complex to discuss in the abstract with a general management audience. Nonetheless, that level of complexity may be helpful both for building tools and for codifying a body of knowledge in the IS field. For example, it may prove more effective to use a concept classification matrix based on the entity types and relationships in the metamodel rather than on the elements in the work system framework.

Next Steps

WST is conceived as an integrated body of theory that encompasses static and dynamic big picture views of systems in organizations and that provides a scaffolding for additional layers of concepts that support analysis and design efforts and that are useful in research about IT-reliant systems in organizations. A key goal of WST is to demonstrate the possibility of using an internally consistent set of assumptions, concepts, frameworks, and principles as a basis for analysis, explanation, prediction, and design and action. The current version of WST seems meet the criterion of internal consistency, although it is certainly possible that someone will identify significant internal consistent problems. To date, previously discussed uses of parts of WST have demonstrated that its basic ideas are usable by business professionals. Whether that usage has occurred or is likely to occur in the future at a satisfying level of rigor and depth is a more problematic issue. That type of issue is difficult to assess for any body of theory for analysis and design and action that is broadly applicable and can be used without extensive training and professional certification. Similar issues were mentioned earlier in relation to UML, BPMN, and soft system methodology. As with many assessments of success, it is likely that results of such as an assessment would hinge largely on where the evaluators set the bar.

The continuing evolution of WST will attempt to incorporate whatever additional ideas, methods, and tools may help in accomplishing its goals. The likely result will be an even broader set of concepts and frameworks that may look even less like a traditional theory, but that might be packaged through various tools and other materials to maximize usability and application. The Appendix presents a long list of possible projects that could develop WST further. There is a lot to do.

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Appendix: 21 Possible Projects for Further Development of Work System Theory

One of the ways of evaluating a theory involves whether it raises questions that are both interesting and possible to pursue. WST is now rich enough in scope and content to point to many interesting directions for future research. It would not be difficult to add a number of projects to the 21 possible projects that are listed below. They are grouped under practical applications of WST, development of tools and methods, theory development, body of knowledge for IS, and teaching. Many of the projects could appear under several headings.

Practical applications of WST

1) Test the usefulness of various versions of the work system method in real world practice. Use the results to improve the work system method in the future. In particular, test whether use of WST by business and IT professionals leads to clearer designs and more successful action, and also whether use of WST leads to clearer, more effective communication between business and IT professionals.
2) Use quasi-experimental methods to characterize differences in both process and results between analysis and design efforts that use WST and analysis and design efforts that use other approaches, such as systems analysis and design approaches suggested in textbooks.
3) Apply WST to applications of social networking tools or other relatively pervasive software (e.g., see El Sawy 2003) in situations that do not involve well defined business processes. Do this in order to explore whether WST helps in understanding the use of such tools and/or to develop new extensions of WST that are useful for analyzing applications of pervasive software that is used intermittently.

4) Use WST to re-interpret success and failure stories in practitioner journals and academic case studies (likely determining that a key issue in many cases involved the extent to which a change or intervention was treated as a work system improvement project or a software project). Another possibility is to compare the results of doing the same re-interpretation exercise based on WST and based on other methods or theories such as soft systems methodology, actor-network theory, activity theory, structuration theory, general systems theory, resource-based theory of the firm, and so on.
5) Use WST to predict eventual success or failure in practitioner journals and academic case studies that have been edited to remove any discussion of the eventual outcomes.

Development of tools and methods

6) Extend the existing linkages between WST and service systems, possibly through new extensions of the work system method that focus more on typical service system issues. (e.g., Tan et al. 2008)
7) Develop ways to combine WST with other theories and methods such as soft systems methodology, use cases and other diagrams from UML, activity theory, actor-network theory, IBM's component business models, the Zachman enterprise architecture framework, or other enterprise architecture models.
8) Develop heuristic methods for translating between structured work system analyses and corresponding UML diagrams or other structured tools from other methods.
9) Develop computerized systems analysis and design tools based on WST. Integrate those tools with tools based on UML or other methods.

Theory development

10) Extend WST so that it does a better job of incorporating communication and coordination issues that are not adequately reflected in typical process models.

11) Extend WST so that it does a better of job of incorporating incremental changes and workarounds, possibly creating an extended version of the work system life cycle model or a theory of workarounds that incorporates the work system framework in conjunction with agency theory and other ideas.

12) Perform a detailed validation of the 24 work system principles in relation to various bodies of theory. One possible outcome is clarification of the degree of the degree to which existing literature supports the existing principles. A more interesting outcome would be a more extensive, layered set of principles, some of which apply to work systems in general, and some of which apply to special cases.

13) Justify the work system framework or other aspects of WST in terms of other theories or philosophical stances.

14) Develop models of real world work systems using the metamodel in Figure 3. Identify insights from the process of developing those models. Use those insights to improve the metamodel and to specify processes for using current or future versions effectively.

15) Extend the short conference paper (Alter, 2010xxx) proposing that the long term discourse on user participation (as summarized by Markus and Mao (2004) could be clarified by using the work system life cycle model and by clarifying differences between users, participants, and non-participant managers.

16) Further develop system interaction theory. Alter (2010xx) explains ways in which the most recent version extends Thompson's (1967) taxonomy of task interdependence, coordination

theory (Crowston et al. 2006), and related views of interactions between systems in organizations.

17) Further develop the theory of work system risk.

Body of knowledge for IS

18) Create a first draft of a body of knowledge for IT-reliant work systems by populating the cells in the concept classification matrix for work systems in general. Ideally, compare several versions done by different groups to identify differences in emphasis and detail.

19) Explore the differences between the body of knowledge for work systems in general and the body of knowledge for special cases such as information systems and projects. Start with a good draft of concept classification matrix populated with concepts and principles that apply to IT-reliant work systems that include human participants. As a way to identify the unique body of knowledge for information systems in general, identify a) concepts that apply to information systems in general and to IT-reliant work systems in general, b) concepts that apply to IT-reliant work systems in general but not to information systems in general, c) additional concepts that apply to information systems but do not apply to IT-reliant work systems in general. Depending on the results in a), b), and c), extend the exercise to identify concepts that are related to special cases of information systems (e.g., supply chain information systems, accounting information systems, etc.) and evaluate whether the special cases are substantially different from IT-reliant work systems in general or information systems in general. Perform a similar analysis using project as the initial special case, and particular types of projects such as ERP implementation or agile programming as the special cases.

20) Prepare an extended version of the blank concept classification matrix based on the metamodel in Figure 3 rather than on the work system framework. Repeat several of the above exercises to determine whether the extended version of the blank matrix is more useful than the one presented in Table 7.

Teaching

21) Develop better methods for teaching the basic ideas of the work system method to undergraduates, MBA students, computer science students, business professionals, and IT professionals.

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