Notes on Work System Concepts

Steven Alter
University of San Francisco
alter@usfca.edu

1.1. The Concept of Work System

"Work system" is a natural unit of analysis for thinking about systems in organizations. In organizational settings, work is the application of human, informational, physical, and other resources to produce products/services. A work system is a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific products/services for specific internal and/or external customers. Immediate implications of thinking of systems in organizations as work systems include:

- By the system nature of work systems, the components and interactions within a work system should be in alignment, implying that all components and interactions should be aligned with the work system's goals. Misalignments and performance gaps for components, interactions of components, and a work system as a whole are important reasons for modifying a work system.

- Based on the definition of work system, work systems exist to produce products/services for their customers. Accordingly, the performance of a work system should be evaluated based partly on the efficiency and other aspects of internal processes and activities, and partially on customer evaluations of the products/services that are produced to provide value for internal and/or external customers.

- By the definition of work system, work systems may be sociotechnical systems in which people perform processes and activities. That possibility diverges significantly from most systems analysis and design textbooks, where "the system" is a configuration of hardware and software that is used by users.

- Based on accumulated real world experience and many hundreds of published and unpublished accounts of sociotechnical systems in organizations, work systems are assumed to evolve over time through a combination of planned change and emergent (unplanned) change. Those changes involve not only changes in hardware and software, the primary focus of IT-oriented life cycle models, but also changes in all other components of a work system.

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 value chain systems (e.g., systems for inbound logistics, operations, sales and marketing, and customer service) and support systems (e.g. systems for procurement and human resources) are IT-reliant work systems that

use IT in order to operate efficiently and effectively. Most are not IT systems, however, because they are not about IT. Table 1 lists representative examples of work systems that were analyzed in recent years by employed MBA students who produced management briefings about work systems in their own organizations. While entire enterprises or organizations can be viewed as work systems, the useful domain for work system analysis involves specific work systems within organizations, such as those listed in Table 1.

Table 1. Examples of work systems selected and 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	• 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 • Approving real estate loans	• 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

Work system is a general case for thinking about systems within or across organizations. There are many important special cases that should inherit most of the properties that are applicable to the general case:

- Information systems are work systems whose processes and activities are totally devoted to processing information through activities including capturing, transmitting, storing, retrieving, deleting, manipulating, and displaying information. (Alter, 2008a)

- Supply chains are inter-organizational work systems whose goal is to provide supplies and other resources required for the operation of organizations that use whatever the supply chain produces.

- Projects are temporary work systems that are designed to produce a set of products/ services, after which they cease to exist,

- Self-service work systems, such as selecting and purchasing products/services using ecommerce web sites, have customers as primary participants. In self-service, customers who perform processes and activities use resources provided for their use to obtain information, make purchases, or achieve other goals.

- Totally automated work systems are work systems in which all of the processes and activities are performed by computer programs, physical machines, and other devices. People who create and maintain those programs, machines, and other devices are not participants in those automated work systems. Rather, they are participants in other work systems that create or maintain automated work systems.

Many work systems use software that is part of commercial enterprise resource planning (ERP) and customer relationship management (CRM) packages. Those software packages are best viewed as infrastructure shared by multiple work systems; the programs that are used in a specific work system can be viewed as part of the technology within that work system.

A complete perspective on work systems needs to cover both a static view of a work system during a period when it is relatively stable and a dynamic view of how a work system changes over time. The work system framework (Figure 1) is a pictorial representation of a work system in terms of nine elements included in a basic understanding of the work system's form, function, and environment during a period when it is relatively stable, even though incremental changes may occur during that period. The work system life cycle model (Figure 2) is a pictorial representation of the iterative process through which work systems evolve over time via a combination of planned change (formal projects) and emergent (unplanned) change that occurs through adaptations and workarounds.
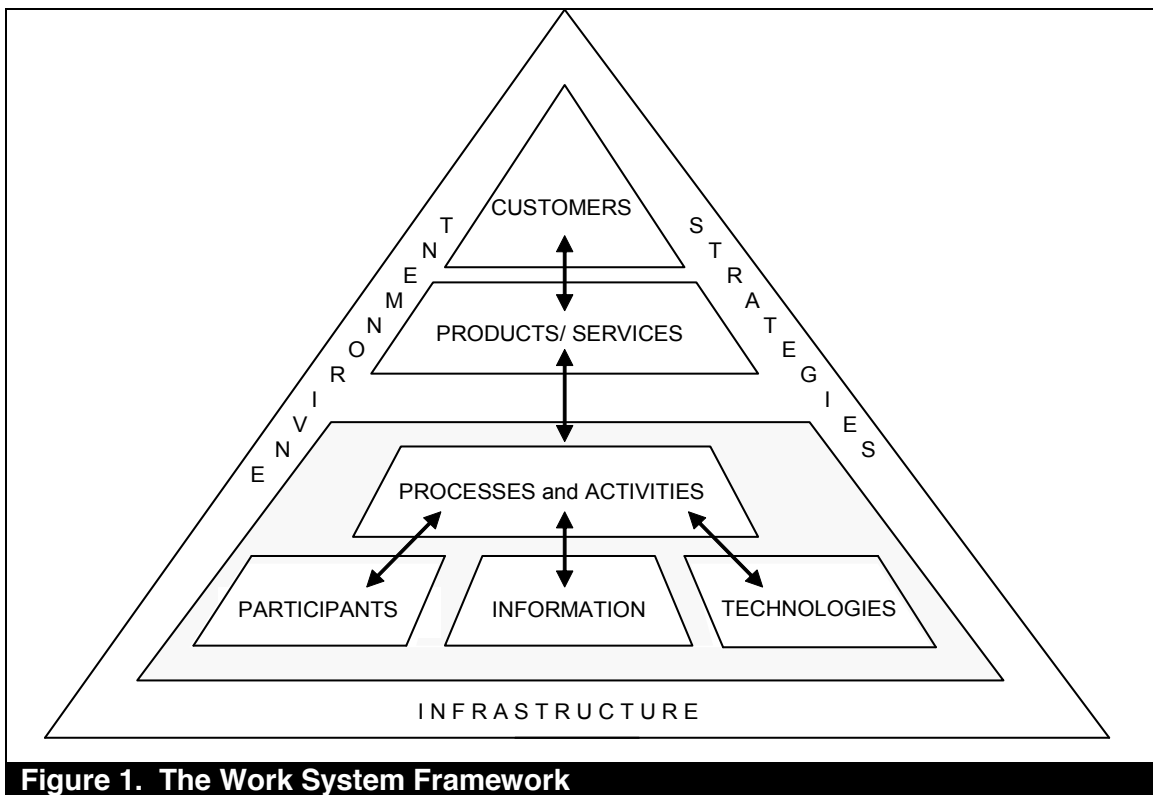

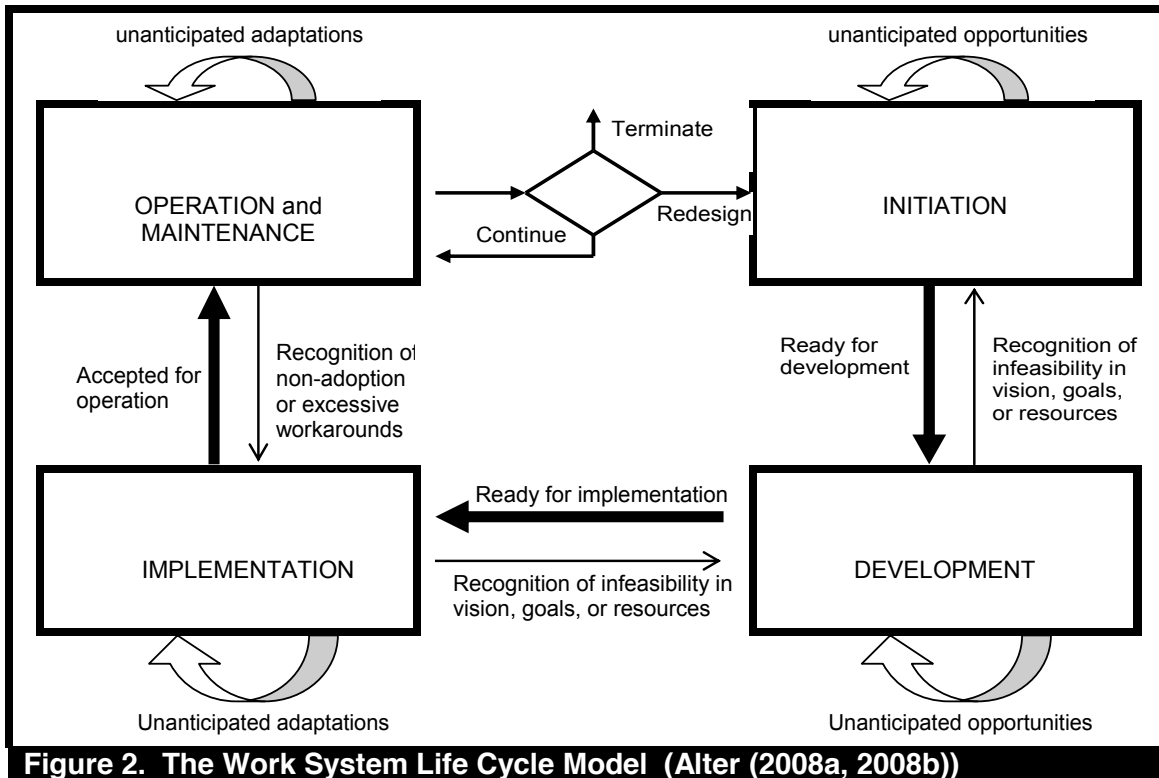**Figure 1. The Work System Framework**

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

1.2. Work System Framework

The work system framework is a useful basis for describing and analyzing an IT-reliant work system in an organization because its nine elements are part of a basic understanding of a work system. The framework outlines a work system's form, function, and environment. It emphasizes business rather than IT concerns. It covers situations that might or might not have a tightly defined business process and might or might not be IT-intensive. Of the nine elements in the work system framework:

- Processes and activities, participants, information, and technologies are viewed as completely within the work system.
- Customers and products/services may be partially inside and partially outside because customers often participate in the processes and activities within the work system and because products/services take shape within the work system.
- Environment, infrastructure, and strategies are viewed as largely outside the work system even though they have direct effects within the work system.

Figure 1 shows that work systems exist to produce products/services for customers. An implication for analysis and design is that there is an inherent trade-off between internal management concerns about performing the work efficiently and maintaining the morale of the participants versus customer concerns about the total cost, quality, and other characteristics of the products/services that they receive.

The arrows inside the work system framework say that the specific elements of a work system should be in alignment. For example, the knowledge, skills, interests, and motivation of the participants should fit with the processes and activities within the work

system. Conversely, the processes and activities should be appropriate for attributes of the participants. Changes in the processes and activities may require related changes in the participants ranging from additional training or new incentives all the way through changing participant roles, replacing some participants with others, or automating parts of the work, thereby rendering some roles unnecessary. Similar alignment issues apply for all pairs of elements that are linked by arrows.

Notice that there is no arrow linking participants and technology. The underlying assumption is that the main relationships and main needs for alignment are between the process and participants, process and information, and process and technologies. That assumption seems adequate for broad-brush work system thinking by most business professionals in most situations. A more detailed representation called a work system metamodel is designed to support more detailed analysis that is closer to the kind of analysis and design done by IT professionals. That metamodel includes an explicit link between participants and specific tools that they use to perform activities within a work system. It is not discussed here.

Table 2 summarizes reasons why inclusion of each element in the work system framework is necessary for even a basic understanding of a work system.

Table 2: Reasons for Including Each Element of the Work System Framework	
Element	*Reason for inclusion in the work system framework*
Processes and Activities	Processes and activities occur within a work system to produce products/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 defined well enough to call it a process by some definitions. 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)), are semi-structured, and are better described as a set of related activities. In relation to systems analysis and design, processes and activities in a work system are viewed from a performative perspective, focusing on how the work actually is performed, rather than an ostensive perspective describing an idealized notion of how the work should be performed.
Participants	Participants are people who perform work within the work system, including both users and non-users of IT. Failure to include participants in an analysis automatically would omit important sources of variation in the results. Inclusion of the term *participant* instead of the term *user* avoids ignoring important participants who do not use computers and minimizes confusion due to referring to stakeholders as users, whether or not they actually use the technology in a work system that is being analyzed. Customers are often participants in work systems, especially in service systems.

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. The distinction between data and information is not important for understanding a work system since the only data/ information that is mentioned is information that is created, used or processed by the work system. Note also that information within a work system includes information that is captured or represented by computers and other information that is never computerized, such as the content of conversations and verbal commitments and unrecorded information/ knowledge that is used by work system participants as they perform processes and activities within the work system.
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, i.e., hardware/software configurations that perform totally automated activities. This distinction is crucial as work systems are decomposed into successively smaller subsystems, some of which are totally automated.
Products/ 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/services consist of information, physical things, and/or actions produced by a work system for the benefit and use of its customers. The term "products/services" is used because the controversial distinction between products and services in marketing and service science is not important for understanding work systems. Note, however, that product-like vs. service-like is the basis of a series of valuable design dimensions for characterizing and designing the things that a work system produces.
Customers	Customers are recipients of a work system's products/ services for purposes other than performing work activities within the work system. Since work systems exist to produce products/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 enterprise's customers, whereas internal customers are work system customers who are employed by the enterprise, such as customers of a payroll work system. Customers of a work system often are also participants in the work system (e.g., patients in a medical exam, students in an educational setting, and clients in a consulting engagement).
Environment	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 operational efficiency and effectiveness of many work systems. 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, design, evaluation, and/or research efforts that ignore important factors in the environment may overlook issues that degrade work system performance or even cause system failure.
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. From an organizational viewpoint rather than a purely technical viewpoint, infrastructure includes human infrastructure, informational infrastructure, and technical 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, department strategy, and work system strategy. In general, strategies at the three levels should be in alignment, and work system strategies should support department 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.

1.3. Work System Life Cycle Model

Figure 2 depicts the work system life cycle model (WSLC) that expresses a dynamic view of how work systems change over time through iterations involving planned change and emergent (unplanned) change.

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

The WSLC represents emergent change using inward-facing arrows that represent ongoing adaptations, bricolage, and workarounds that change aspects of the current work system without separate allocation of significant project resources. The inward facing arrows for all four phases of the WSLC emphasize that emergence occurs not only through incremental changes in operational systems, but also through changes that occur within different phases of formal projects. The inward-facing arrow for the operation and maintenance phase starts with short term adaptations and workarounds of cumbersome processes. It also includes longer term changes in practices or goals that

occur as adaptations and workarounds are incorporated into organizational routines (e.g., Feldman and Pentland, 2003) without requiring formal projects. Emergence during the initiation phase may lead to goals that were not initially anticipated; emergence during the development phase may lead to new understandings and new combinations of functions and issues that were not anticipated in the initiation phase; emergence during the implementation phase may lead to modifications of initial intentions concerning important aspects of the "to be" work system, including process and activity patterns, uses of technology and information, and expectations related to responsibilities and activities of work system participants.

The WSLC differs fundamentally from the "system development life cycle" (SDLC), which is basically a project model rather than a system life cycle. Some current versions of the SDLC contain iterations, but even those are iterations within a project. The system in the SDLC is a basically a technical artifact that is being created. In contrast, the system in the WSLC is a work system that evolves over time through multiple iterations. That evolution occurs through a combination of defined projects and incremental changes resulting from adaptations, making do with whatever is available, and creating workarounds to bypass obstacles. In contrast with control-oriented versions of the SDLC, the WSLC treats unplanned changes as part of a work system's natural evolution. Comparison of the WSLC with alternative system development life cycle approaches is beyond this paper's scope.

Since many terms related to work systems have been introduced, at this point is it worthwhile to provide a glossary of terms (Table 3) that incorporate the term *work system*. The glossary is also important because different people have used these terms in different ways, sometimes demonstrating a lack of clarity about the difference between basic ideas in the work system approach.

Table 3: Definition of key concepts in work system theory	
Concept	Definition in relation to WST
Work	In organizational settings, the use of human, informational, physical, and other resources to produce products/services.
Work system	A system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce products/services for internal and/or external customers. Work systems are sociotechnical systems by default, although the definition also encompasses totally automated work systems with no human participants.
Special cases of work systems	Special cases of work systems include information systems, supply chains, projects, self-service work systems, and totally automated work systems, among others. For example, an information system is a work system in which all of the processes and activities involve processing information. Most concepts related to work systems in general are inherited by the special cases.
Work system framework	Representation of 9 elements of a basic understanding of a work system as it exists during a time span when it maintains its

	identity and integrity even though incremental changes may modify certain details of its form and/or function.
Work system life cycle model (WSLC)	Representation of the iterative process by which work systems evolve over time through a combination of planned change (projects) and emergent (unplanned) change that occurs through bricolage, adaptations, and workarounds.
Work system method (WSM)	Systems analysis and design method based on analyzing an "as is" work system and designing an improved version called the "to be" work system. Different versions of WSM have been used, with shortcomings of previous versions leading to improvements in subsequent versions.
Work system snapshot	A basic tool used in WSM. A formatted, one-page summary of the work system in terms of six elements of the work system framework: processes and activities, participants, information, technologies, products/services produced, and customers of the work system. Used for summarizing the "as is" work system and the recommended "to be" work system.
Work system principles	General principles that should apply to all work systems.
Work system design spaces	A set of design spaces based on the work system framework that may help business and/or IT professionals identify possibilities for improving a work system.
Work system metamodel	Conceptual model identifying entity types and relationships that can be used to describe a work system in more detail than is represented by the work system framework. (Not discussed here)

3. The Work System Method

WSM is a flexible system analysis and design method that is based on work system ideas. It treats the system of interest as a work system and builds upon the work system framework and WSLC. WSM was created for use by business professionals, and can be used jointly by business and IT professionals as part of the initial analysis for designing work system improvements that may or may not involve producing software. It can be used for high-level guidance in thinking about a work system or can organize a relatively detailed analysis through use of a work system analysis template. WSM was originally developed as a straightforward application of general problem solving that started from whatever work system problems, opportunities, or issues launched the analysis. The most notable aspect of WSM in relation to other analysis and design methods is that the current and proposed systems are work systems rather than configurations of hardware and software that are used by users.

WSM was designed to be usable for different purposes and at different levels of detail because the specifics of a situation determine the nature of the understanding and analysis that is required. An executive can use WSM at a highly summarized level in the initiation phase of the WSLC to think about whether a system-related investment proposal is actually about improving a work system (rather than just acquiring software), and whether the comparison of the "as is" and "to be" work systems convincingly implies that business performance will improve. A manager may simply want to ask questions to

make sure someone else has done a thoughtful analysis. Implementers, change agents, and work system participants can use various aspects of WSM to think about how the "as is" work system operates, how well it operates, and how and why possible changes might generate better results for the organization and for specific stakeholders. IT professionals can use the ideas in WSM for understanding system-related situations from a business viewpoint and for communicating more effectively with business professionals who are the customers for their work.

Evolution of WSM. To date, over 700 student papers using various versions of work system analysis templates have been collected from courses in the United States, China, Vietnam, and Australia. The vast majority of those papers were produced by employed MBA or Executive MBA students doing a preliminary analysis of a work system in an organization that they or a team member worked in. Results from analyzing these papers appear in Alter (2006a) and Truex et al. (2010, 2011). The literature includes other reports related to applying work system concepts related to ERP systems (Petkov and Petkova, 2008; 2010) and use of simplified work system analysis by freshman IS students (Recker and Alter, 2012).

Illustrative example. Table 4 illustrates the general logic of WSM by summarizing a business case template used by Executive MBA students in Vietnam in 2012. This template was used for a final group paper in a short course designed to combine an overview of work system analysis with an overview of project management. After considering IT-reliant work systems in their own organizations, each group selected a single IT-reliant work system with important problems or opportunities. The groups applied work system thinking by conceiving the situation in work system terms, summarizing the "as is" work system, drilling down to understand the problems and opportunities in more detail, and then proposing a "to be" work system. The justification of the proposal had to consider the project of converting from the "as is" work system to the "to be" work system, thereby including project management issues covered in the course. Because the students were working full time, their analyses were necessarily much more cursory than a real world analysis should be. In particular, there was very little opportunity to gather data other than any data that already existed in the setting.

Table 4. Example of the Work System Method in the form of a Business Case Template	
Main Heading	**Topics included**
1. Executive summary	1. Brief summary of the "as is" work system, the problem, and the proposed improvements.
2. Background	1. Brief background needed to understand the context of the analysis.
3. System and problem	1. Name of work system 2. Main problems or opportunities 3. Significance of the work system 4. Constraints that limit the possible recommendations 5. Internal performance gaps (related to processes, participants, information, technologies) 6. External performance gaps (related to customers and products/services)

	7. Discussion of performance gaps 8. Work system snapshot of the "as is" work system 9. Customer value and customer concerns for primary customers 10. Customer responsibilities for primary customers
4. Analysis and possibilities	(Looking at the situation through various lenses, such as issues in the process rationale, Pareto analysis, fish-bone diagrams, etc.)
5. Recommendation and justification	1. Summary of recommendation 2. Work system snapshot of the "to be" work system 3. Likely impact of recommended changes 4. Brief summary of the cost/benefit rationale
6. Project plan	1. Project ownership and governance 2. Criteria and method for evaluating success 3. Summary of the project (main steps, dates, deliverables, resources) 4. Major risks and pitfalls

There are a number of other variations on WSM. The main commonality between all of them is that the situation is conceived as a work system with performance problems or opportunities and that the current and proposed work systems are summarized using the format of a work system snapshot. In all cases, the scope of the work system is treated as a choice rather a given. The general rule of thumb is that the work system for the analysis is the smallest work system that exhibits the problems or opportunities that motivated the analysis.

Work system snapshot. Table 5 is an example of the "work system snapshot" mentioned in Table 4. It is a formatted one-page summary of a work system in terms of the six central elements of the work system framework: customers, products and services, processes and activities, participants, information, and technologies. The example in Table 5 combines aspects of several work system snapshots related to hiring systems. The requirement of not exceeding one page helps focus attention on the scope of the system and prevents getting overwhelmed at the outset in details that subsequent analysis will reveal.

The other three elements of the work system framework (environment, infrastructure, and strategies) are not included in the work system snapshot for the sake of simplicity when focusing on the appropriate scope for the work system in relation to the problems and opportunities at hand. These three elements are considered as the analysis goes into more depth. The distinction between technical infrastructure and technology within the work system is unimportant for a first-cut summary but may prove important later as the analysis distinguishes between technologies that are directly associated with the specific work system and other technologies that are shared by multiple work systems.

Table 5. Work system snapshot of a recommended "to be" work system	
Customers	**Products/ Services**
Hiring manager Larger organization (which will employ the new hire) HR manager (who will analyze the nature of applications)	Applications (which may be used for subsequent analysis) Job offers Rejection letters Hiring of an applicant

Major Activities and Processes

Hiring manager submits request for new hire within existing budget
Staffing coordinator defines the parameters of the new position.
Staffing coordinator publicizes the position.
Applicants submit job applications.
Staffing coordinator selects shortlisted applicants.
Hiring manager identifies applicants to interview.
Staffing coordinator sets up interviews.
Hiring manager and **other interviewers** perform interviews.
Hiring manager and **other interviewers** provide feedback from the interviews.
Hiring manager makes hiring decisions.
Staffing assistant sends offer letters or rejections.
Successful **applicant** accepts or rejects job offer or negotiates further.

Participants	Information	Technologies
Hiring managers Staffing coordinator Applicants Staffing assistant Other employees who perform interviews	Job requisition Job description Advertisements Job applications Cover letters Applicant resumes Short list of applicants Information and impressions from the interviews Job offers Rejection letters	New HR portal that is being built Word processor Telephones Email

Despite the textual nature of work system snapshots, they require rigorous thinking because of consistency rules including:

- Each of the processes and activities listed in the work system snapshot must be stated as a complete sentence that briefly specifies which participants perform the work and what they do.
- Each participant group must be involved in at least one step in the processes and activities. Customers are viewed as participants if they participate in at least one of the steps.
- Each informational entity and technological entity listed under information and technologies must be created or used in at least one step in the processes and activities.
- Each product/service in the work system snapshot must be the output of at least one step in the processes and activities.
- Each product/service must be received and used by at least one customer group.
- Each customer group must receive and use at least one product/service.