

# Where Do Services Fit in Systems Analysis and Design?

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## Abstract

The term “service” appears in the IS field in contexts ranging from visible business activities performed for customers through invisible computerized responses to computerized requests deep within IT infrastructures. Leading technology companies are promoting the development of “services science” because technical and nontechnical services are very important to their operation and their future.

This paper frames a possible debate about where services fit in SA&D. Skipping background topics and issues about various definitions of service that would be included in a more complete paper, it distinguishes between four lenses for understanding and analyzing services. Each lens is directly applicable to many situations, and less applicable elsewhere. There are two questions for SA&D:

- 1) Should SA&D address services in any direct way, as opposed to viewing services as essentially similar to other systems?
- 2) If SA&D should address services in any direct way, which of the four lenses (or any other lenses) would be applicable, and how could any of them become more useful for SA&D?

## Defining Service

Defining services in IS is difficult because services provided by people differ substantially from services provided by computers. Researchers and practitioners in marketing and operations typically assume that services involve human service providers and human service consumers who may use IT while performing or receiving the service. The quality of interactions between service providers and service consumers is often viewed as the essence of service. Accordingly, the provider’s thoughtfulness and ability to recognize and respond to the consumer’s stated or unstated needs, interests, and concerns is essential for service quality.

In contrast, computer scientists view service in relation to client-server computing, whereby client entities pose unambiguous requests to server entities, which produce unambiguous responses. Client and server process interact through definable IT-based

interfaces. Neither can discern unstated needs, interests, concerns, or methods of the other. Statements in *IBM Systems Journal* illustrate this paradigm:

A service “is generally implemented as a course-grained, discoverable software entity that exists as a single instance and interacts with applications and other services through a loosely coupled (often asynchronous), message-based communication model.” (Brown et al, 2005)

“The component that consumes business services offered by another business component is oblivious to how the provider created the business service.” (Cherbakov et al, 2005)

IS researchers have approached services from both directions. Research about service organizations, service products, the service economy, and customer service mostly concern services with human providers and human consumers. Even IT-based services such as Internet service provision and online auctions are often viewed as having human providers who provide technical capabilities used by human customers. Current interest in ITIL and COBIT is about managing and controlling IT services provided by IT groups for business organizations. In contrast, other IS researchers work on the technical and conceptual underpinnings of service-oriented architectures.

***Definition of service.*** We adopt a simple, dictionary-like definition by which the following are all services: performing surgery, installing networks, producing customized software, providing Internet-based search capabilities, accepting orders through an ecommerce web site, building houses, producing televisions, providing leisure opportunities on golf courses, performing legal work, and selling groceries.

*Services are acts performed for someone else, including the provision of resources that someone else will use.*

The definition also covers special cases such as self-service and automated services for people. In self-service, service providers provide resources that are used by customers performing self-service activities. In automated services for people, machines perform the service activities.

In the realm services computing “another entity” replaces “someone else.”

*Services are acts performed by one entity for another, including the provision of resources that another entity will use.*

## **Four Lenses for Understanding Systemic Activities Related to Services**

The breadth of service-related interests in IS raises an awkward question about whether these areas actually have any genuine commonality of content or language other than the word *service*, the relevance of IT, and the attention of researchers associated with IS.

This paper uses a 2x2 framework (Figure 1) to explore complementarities between different lenses for understanding and analyzing service in the IS field. The term *lens* is used because each approach in Figure 1 brings a variety of concepts, methods, and connotations. The dimensions in Figure 1 are system emphasis versus service emphasis and sociotechnical versus primarily technical. The first dimension represents differences between thinking of service situations starting from system concepts versus starting from service concepts. Sociotechnical versus primarily technical refers to whether the analysis focuses largely on human actors and activities versus technology and automated activities.

The icons in Figure 1 correspond with four service-related lenses for understanding and analyzing systematic activities in organizations:

- IT-reliant work systems
- Co-creation of value
- Outputs of IT-based tools
- Services computing.

Each lens will be summarized independently. Subsequent sections identify complementarities and synergies between the lenses. Synergy between lens A and lens B exists when applying lens A augments an analysis of systemic activities guided primarily by lens B. The individual lenses and pairwise combinations provide rich and potentially useful approaches for thinking about services in the IS field.

## **Lens #1: IT-Reliant Work Systems**

IT-reliant work systems are sociotechnical systems in which human participants and/or machines perform work using information, technology, and other resources to produce products and services for internal or external customers. (Alter, 2003, 2006, 2008). The triangular icon in the upper left of Figure 1 represents the work system framework, which emphasizes business rather than IT concerns and was developed to help business professionals recognize and understand IT-reliant systems in organizations. That framework (Figure 2) identifies nine elements included in even a rudimentary understanding of a work system. Almost all significant sociotechnical systems in today's business world are IT-reliant and therefore fall within the scope of the IS field.

The work system framework organizes a large number of concepts related to each of its elements and to work systems as a whole. Those concepts can be combined in many ways for describing, analyzing, and designing systems in organizations. For example, a system's design involves big picture design choices such degree of structure, level of integration, complexity, rhythm of operation, and treatment of exceptions and errors. (Alter, 2006) Typical systems analysis texts say little or nothing about big picture design

choices such as those, in effect assuming that big picture design choices are either irrelevant or relatively obvious to analysts, designers, and their clients.

The use of lens #1 is an organized approach for thinking about services as sociotechnical systems that produce services, defined previously as acts performed for someone else, including the provision of resources that someone else will use. Conversely, all work systems, even those that produce physical things, can be viewed as service systems because they perform processes and activities for others.

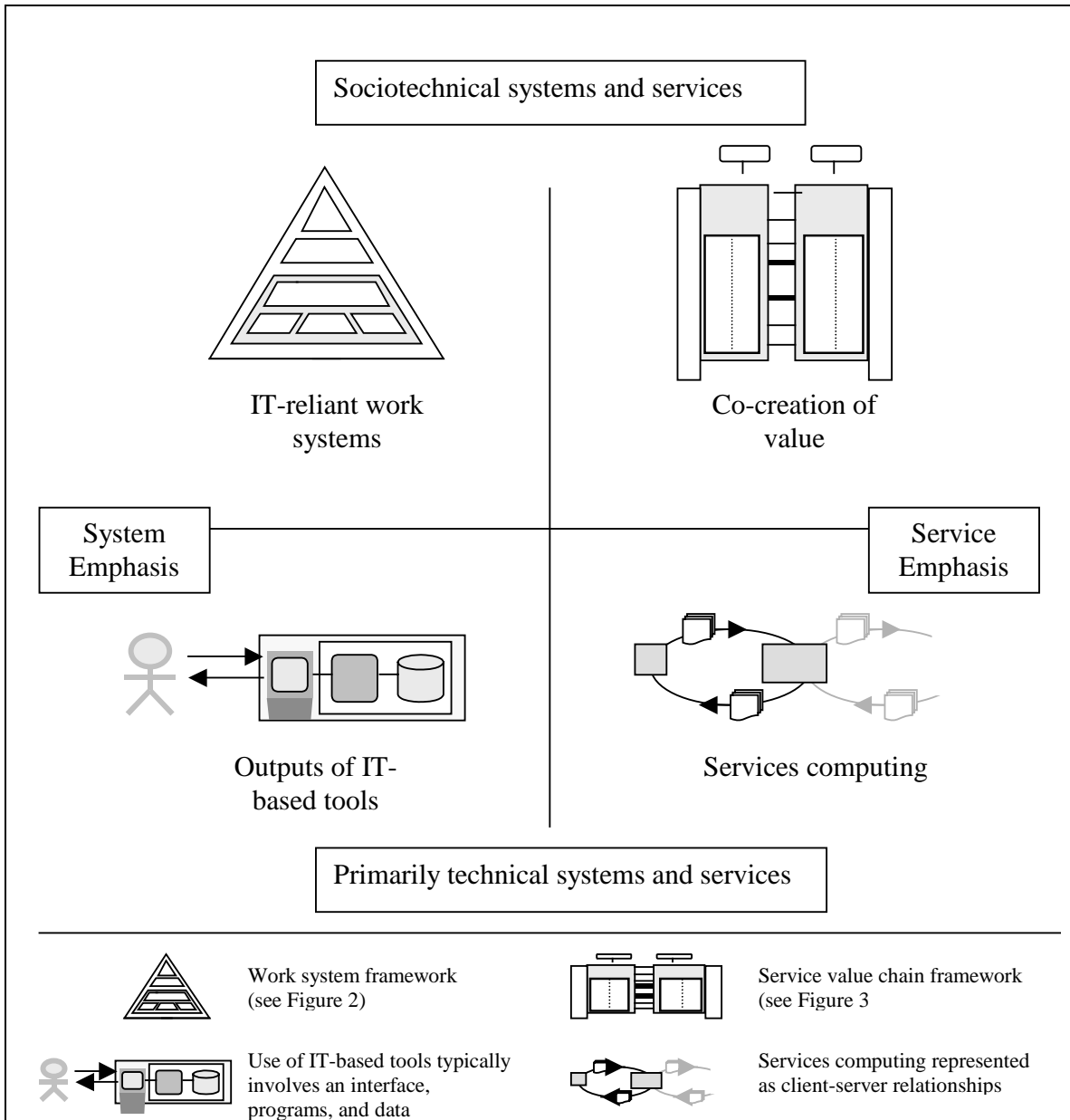


Figure 1: Four Lenses for analyzing systematic activities

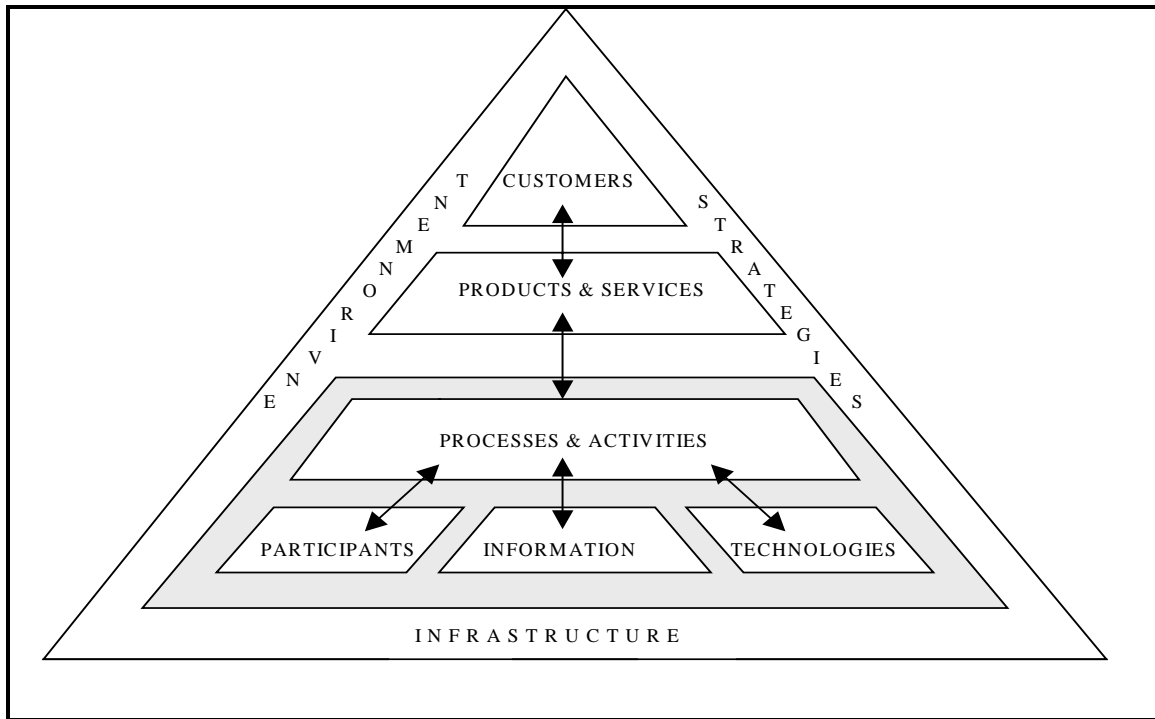
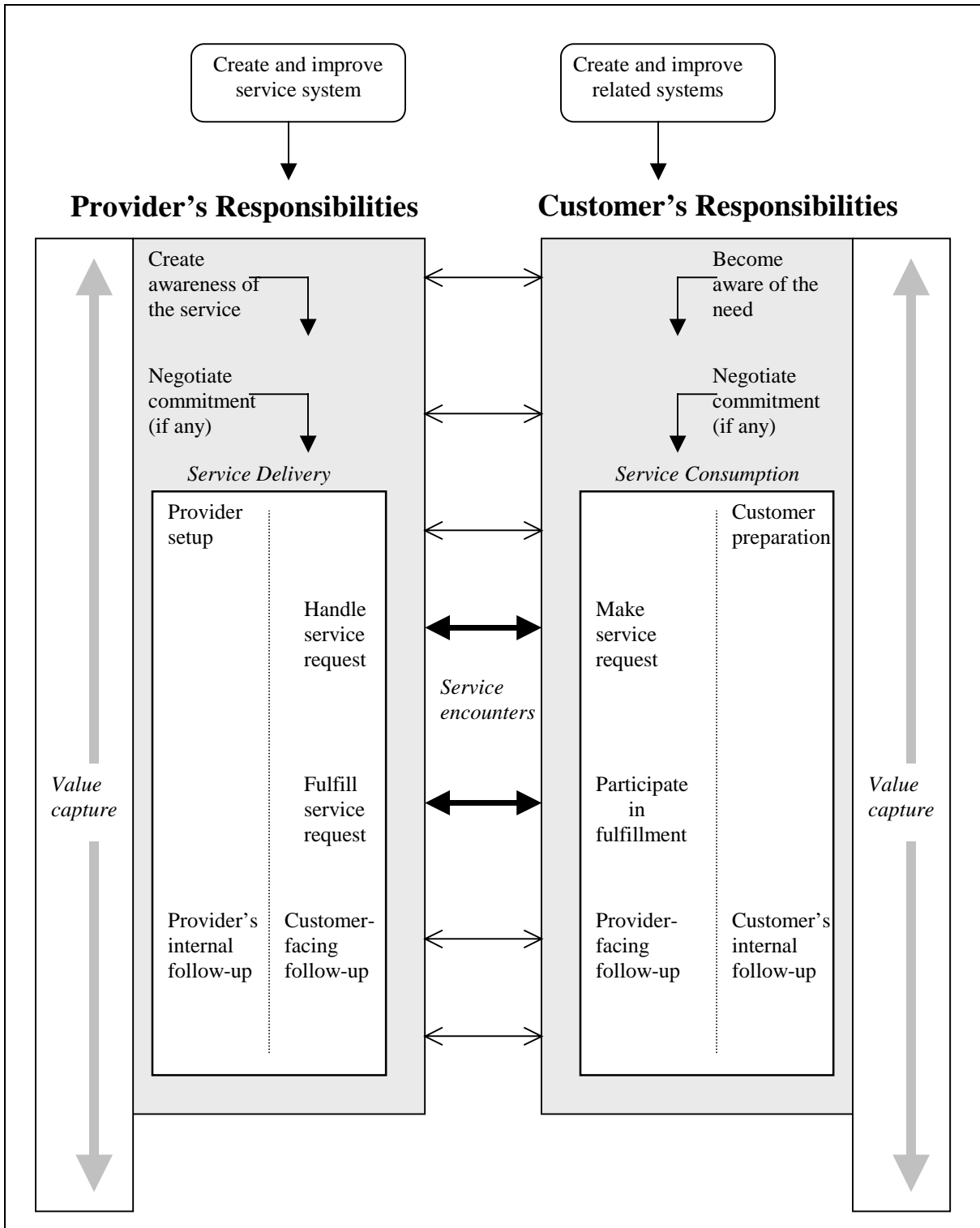


Figure 2. The Work System Framework (slightly updated). (Alter, 2007a; 2008)

## Lens #2: Co-Creation of Value

Service as a value co-creation appears in the upper right of Figure 1 as an icon for the service value chain framework (Figure 3), whose two columns represent value co-creation by human service providers and service consumers. This framework is a generic value chain model that highlights components of services. Its motivation and terminology were discussed in Alter (2007a, 2008). Its form and content incorporate ideas often associated with services, such as:

- **Co-creation of value.** Services involve activities and responsibilities of both service providers and service customers.
- **Internal and external customers.** Basic ideas about services are largely the same regardless of whether services are directed at external or internal customers.
- **Customer experience.** The entire experience of acquiring, receiving, and benefiting from service affects customer satisfaction.
- **Beyond fulfilling a request.** Although fulfillment of service requests is typically viewed as the core of services, activities related to awareness, negotiation, setup, handling of the request, and follow-up impact service quality and satisfaction.



**Figure 3: Service Value Chain Framework (Alter, 2007a, 2008)**

- **Negotiated commitments.** Many service situations involve service delivery based on negotiated commitments under which the service may be requested and delivered repeatedly.
- **Preparation.** Preparation by providers and/or customers prior to instances of service delivery is often essential for service efficiency and effectiveness.
- **Service request.** Each instance of service delivery may include explicit or implicit service requests. Handling of these requests is part of service delivery and often affects customer satisfaction.
- **Front-stage and back-stage.** Services often involve front-stage and back-stage activities by both providers and customers.
- **Follow-up.** Some services require follow-up by providers and/or customers. Follow-up may be related to a single service instance (Was the installation OK?) or to multiple service instances (How responsive is your account manager?).
- **Value capture.** Both customers and providers experience benefits and perceived value as the service is negotiated and produced, and sometimes later.

### **Lens #3: Outputs of IT-Based Tools**

IT-based tools are technical entities that produce services by responding to user requests. The icon in the lower left of Figure 1 represents a user issuing a command through a user interface and receiving a response. In addition to a user interface, such tools often contain or link to databases.

With Lens #3, the systems of interest are technical tools, and “using the system” is equivalent to using the tool. Table 1, based on Table 2 in Alter (2004), compares primary concerns when using lens #1 or lens #3. Although most systems analysis textbooks give a brief nod to organizational, personal, and competitive issues, most adhere to a version of lens #3 by focusing primarily on building computerized artifacts that satisfy externally provided requirements. For example, Table 2 shows how three systems analysis textbooks view systems as technical artifacts that are used by users, and systems analysis and design as focusing on users, use of systems, and what users want from systems. One would not typically speak of using an IT-reliant work system in the same sense. With the approaches in Table 2, it is not surprising that one of the key diagrams in UML is called the use case.

Beyond just SA&D, use of IT-based tools is a dominant metaphor in the IS field. The IS field searches for the determinants of IT usage (e.g., the technology acceptance model (TAM)) and the impacts of IT usage on people, organizations, and business performance. The controversy surrounding “IT Doesn’t Matter” (Carr, 2003) is closely related because its basic argument concerns whether IT investment generates better business results.

Table 1: Comparing a “tool view” with a “system view” of information systems

	<b>Using lens #1: IT-reliant work systems</b>	<b>Using lens #3: Outputs of an IT-based tool</b>
Headline	The system of doing something	The tool that is used
Role of people	Participants in the system	Users of the tool
Information	Whatever codified or non-codified information produced or used by the system	Whatever information is stored or processed by the tool
Technology	The system may use a variety of technologies that may or may not involve IT.	The tool is the technology or is a part of the technology
Customers	People who receive and use whatever the system produces.	Users of the tool or whatever the tool produces
Performance variables related to operation	Measure how well the system operates internally and how good are the services it produces	Measure how well the tool operates and how well it is used. Metrics include user satisfaction, uptime, ease of use, extent of use
Life cycle model	Model in which the system is created and then evolves through a series of iterations of system in operation, initiation of changes, development efforts, and implementation of changes in the organization.	A project-oriented model related to defining, creating or acquiring, and installing the tool
Main issues in analysis and design	Create or improve a sociotechnical system, assuming that technical and social issues may be intertwined.	Produce a tool that meets requirements in a cost effective manner, can be installed successfully, and is likely to be used as intended.

Table 2: “System as tool” reflected in textbook views of analysis and design for information systems

<i>Textbook</i>	<i>Brief excerpt from description of systems analysis and design as phases of the system development life cycle (SDLC)</i>
Dennis et al, [2002]	<p><u>Analysis Phase:</u> “The analysis phase answers the questions of who will use the system, what the system will do, and where and when it will be used.” [p. 5]</p> <p><u>Design Phase:</u> “The design phase decides how the system will operate, in terms of the hardware, software, and network infrastructure; the user interface, forms, and reports, and the specific programs, databases, and files that will be needed.” [p. 6]</p>
Hoffer et al [2002]	<p><u>Analysis Phase:</u> “In [the requirements definition subphase] ... analysts work with users to determine what users want from the proposed system ... The output of the analysis phase is a description of (but not a detailed design for) the alternative solution recommended by the analysis team. Once the recommendation is accepted ... you can begin to make plans to acquire any hardware and system software needed to build or operate the system as proposed.” [p. 21]</p> <p><u>Design Phase:</u> “You must design all aspects of the system from input and output screens to reports, databases, and computer processes. You must then provide the physical specifics of the system you have designed...” [p. 21]</p>

Kendall and Kendall [2002]	<u>Analysis Phase:</u> [subdivided into three phases] [pp. 10-12] ... “identifying problems, opportunities and objectives” ...”determining information requirements for the particular users involved” ... “analyzing system needs” [using tools such as data flow diagrams and data dictionaries].
	<u>Design Phase:</u> The design phase includes: ... logical design of the information system ... data entry procedures ... user interface design ... file or database design ... controls and backup procedures. [p. 12-13]

## Lens #4: Services Computing

Services computing is organized and described around client programs or devices that request services from server programs or devices. The requests and responses are formal messages. The icon for services computing in Figure 1 starts with a request sent from the client to the server, which may request information from other devices in the background. Eventually the server provides the requested data or confirms that the request was carried out (as in printing).

Service-oriented architecture (SOA) applies services computing as a programming architecture that builds applications from software services that are self-contained and are unaware of the context or state of other services. The message-based loose coupling between services facilitates building software systems from software modules that convert defined inputs into defined outputs used by other modules that may have been programmed at different times for different purposes. Often touted as promoting organizational flexibility, SOA facilitates the use of legacy software in conjunction with newer software developed according to current programming practices.

The structure of lens #4 superficially resembles lens #2. For example, Figure 1 in zur Muehlen et al (2005), which concerns web services choreography standards, represents inter-organizational process integration as occurring through messages (analogous to service interactions) between two organizations (analogous to provider and consumer), each having both private and public processes (back-stage and front-stage). Despite the structural similarity, lenses #2 and #4 differ substantially in context and terminology. For example, a description of IBM’s “business architecture for a service-oriented enterprise” (Nayak et al, 2007) refers to services being “exposed” through a catalog, “discovered” by searching a catalog, and invoked (automatically) only if a service agreement exists. Typical business professionals would not use such terms to describe service provision by human providers for human customers.

## **Synergies and Complementarities between the Lenses**

Each of the four lenses is valuable in many situations, and each has many layers that cannot be mentioned in this brief paper. Where sociotechnical issues are important, service analysts and researchers should use variants on lenses #1 and #2. Where the primary issues concern the use of IT-based tools or development of software, the two primarily technical lenses are more relevant.

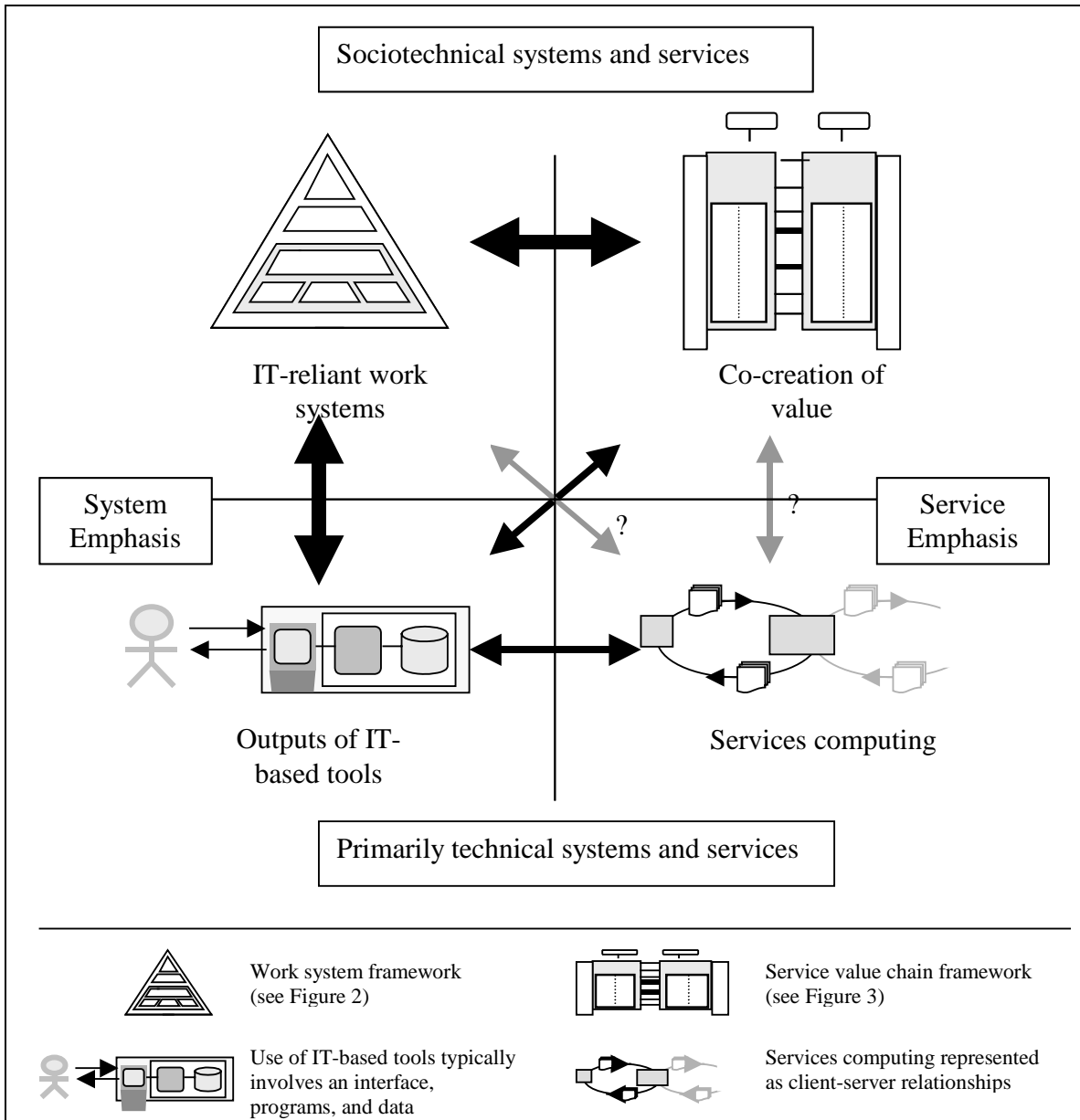
The richness of each approach can provide value beyond simply serving as the primary lens for an analysis. It is worth considering whether each might be applied for additional perspective and insight when any of the others guides an analysis.

The arrows between pairs of lenses Figure 4 show that strong complementarities and synergies between the two sociotechnical lenses and between the two system lenses are readily apparent. Synergies in two other pairs have less potential. Synergies between the other two pairs seem questionable. Due to space limitations, we focus on the value of complementarities rather than on reasons for the weakness of weak complementarities.

### **Synergies between the sociotechnical lenses**

Lens #1, “services as IT-reliant work systems” includes products and services but says nothing specific about service. Lens #2, “systems as value co-creation,” focuses on generic processes related to services, service interactions, back-stage and front-stage, and value capture, thereby reflecting typical situations in which service providers negotiate and provide services for service consumers. It makes no explicit reference to most of the elements of a work system.

Using lens #1 to complement lens #2 by thinking of a service process as an IT-reliant work system brings a wealth of concepts and analysis tools. Thinking about participants, information, technology, processes and activities, and environment typically raises many important issues for understanding any service situation. The secondary layers beneath the work system framework provide many additional ideas that may be useful, such as work system principles, different types of work system changes, work system metrics, risk factors, stumbling blocks, and analysis techniques related to work systems. (Alter, 2006) Implicitly or explicitly, discussions of services often address customer-centricity, which can be increased or decreased through decisions related to various work system elements. For example, a work system’s customer-centricity might be increased by customizing the products and services it produces, by changing its processes to accentuate co-creation, and by using customer information more effectively. (Alter, 2007b)



**Figure 4: Relative strength of synergies and complementarities between pairs of lenses**

Conversely, concepts in lens #2 provide ways to augment lens #1. First, focusing on value co-creation raises the issue of whether an analysis based on lens #1 tends to emphasize a service provider's view and deemphasize the consumer or customer's activities and responsibilities. The generic service steps in lens #2 are a reminder that topics such as negotiation, preparation, requests, and follow up might be overlooked accidentally. However, if customer responsibilities are unimportant in the analysis, emphasizing co-creation could increase complexity unnecessarily.

Articulation between the lenses can occur at different levels. For example, the entire service value chain for a particular service might be viewed and analyzed as a single work system. Alternatively, different subsystems in Figure 3 (such as provider or customer preparation) might be analyzed as separate work systems.

### **Synergy between service-as-system lenses**

Lenses #1 and #3 both take a system viewpoint. With lens #1, the system is an IT-reliant work system. With lens #3, the system is a tool whose outputs are conveyed through a user interface. With lens #1, people and/or machines in the system do the work. With lens #3, people called users use systems as tools.

The synergy between these two lenses is based on topics that the other tends to deemphasize. Users of lens #1 focus more on how work system participants perform activities, while deemphasizing issues related to user interfaces, tool capabilities, and tool structure. Use of lens #3 makes it more likely that tool issues will be addressed. The potential value of using lens #3 in conjunction with lens #1 increases when more of the work is done by machines rather than people. With the trend toward automated business processes and automated decision-making, a lens that emphasizes the use of IT-based tools becomes more valuable. In totally automated work systems, machines do all of the work and participants move to the infrastructure that supports the work system. Concepts and methods related to the other work system elements remain relevant, however.

In the opposite direction, the core of current practice in systems analysis seems to assume that the goal is to build precisely specified software-based tools. Explicit inclusion of work system ideas from lens #1 potentially enriches the analysis and helps in understanding that better tools address only part of work system problems, which often involve issues such as inappropriate processes, inadequate information, inadequate training and knowledge, and inadequate attention to customers.

### **Possible synergy between primarily technical lenses**

Lenses #3 and #4 both assume that entities (users or programs, respectively) use an interface to make requests to server entities that perform a set of functions and provide a response. These lenses are sufficiently similar that they may lack interesting complementarities other than the human user in #3 versus the machine client in #4. Clarification of the content of the lenses and links between them is a worthwhile challenge for future work.

### **Possible synergy between co-creation of value and outputs of IT-based tools**

The co-creation of value (lens #2) often involves the use of IT-based tools (lens #3). Consequently, the analysis of a service value chain, even when the human participants are not included, may lead to useful insights about which tools and tool characteristics are

likely to be effective or ineffective. Similar issues would emerge in more depth, however, if the steps related to value co-creation are viewed as IT-reliant work systems rather than steps that happen to use IT. Use of lens #3 rather than #1 in conjunction with #2 would tend to omit many concepts and issues that would emerge if lens #1 were applied instead.

### **Lack of synergy between value co-creation and services computing**

Although value co-creation and services computing are both on the systems-as-services side of Figure 1, thinking of services delivered by people in terms of services computing adds little or no insight. The services computing view assumes that software services are loosely coupled, that they respond only to rigorously defined requests in particular formats, and that the client and server are mutually unaware of each other's state. In contrast, the sociotechnical view emphasizes the quality of service interactions between people, the importance of empathy, and the importance of understanding customer status and needs. A sociotechnical analysis based on value co-creation typically pays scant attention to the internal structure of software that supports various steps.

### **Lack of synergy between IT-reliant work systems and services computing**

The relationship between lenses #1 and #4 seems even weaker. Lens #1 incorporates the richness and variability of human activity. Lens #4 is based on the predictability inherent in providing rigorously specified requests and automatically producing rigorously specified responses.

## **Conclusions**

*Applicability to services in the IS field.* Each of the four lenses is relevant to many different types of services in the IS field, as illustrated with two examples:

Software as a service (SaaS) can be approached from all four viewpoints:

- as an IT-reliant work system in which the customer's staff performs its work using software hosted by the vendor
- as value co-creation involving the vendor and its customer
- as a situation involving services provided as outputs of IT-based tools
- as a situation in which services computing is used (or not used) in the architecture of the SaaS offering.

Similarly, ITIL and COBIT can be understood:

- as a number of IT-reliant work systems that produce services

- as numerous instances of value co-creation involving an IT group and the organization being served
- as a number of situations involving services provided at least partly as outputs of IT-based tools
- as a number of situations in which services computing is used (or not used) for providing desired IT services.

Relevance to these and other service-related topics in the IS field implies that exploration of synergies and complementarities between different service-related lenses has potential value.

**Limitations.** Many points in this paper were stated briefly due to the word limit. Nonetheless, several limitations would be apparent even with fuller explanations. First, four specific lenses were presented. Other lenses might have generated different observations. In addition, the two primarily technical lenses are less clear than the two sociotechnical lenses, which were articulated clearly in previously published frameworks. As is apparent from examples such as Umaphy and Puroo (2007), the current terminology of services computing is in flux, as is the relationship between services computing and the IT-based tools that people use. Fuller articulation of ideas in both areas would make it possible to explain and contrast lenses #3 and #4 more clearly. It is possible that the clarifications could develop out of ongoing research related to the application of speech act theory, e.g., Dietz (2007), which is also based on formal requests and responses.

**Implications for SA&D.** This paper summarized four lenses, each of which is potentially useful in many SA&D situations. At least several lenses need to be expressed more clearly and need to be linked to relevant analysis methods and tools. The paper also said a bit about how the lenses might be used in combination.

This paper's goal was more about raising questions rather than about answering them. The abstract identified two questions for SA&D:

- 1) Should SA&D address services in any direct way, as opposed to viewing services as essentially similar to other systems?
- 2) If SA&D should address services in any direct way, which of the four lenses (or any other lenses) would be applicable, and how could any of them become more useful for SA&D?

If the ideas in this paper make sense, SA&D has an opportunity to address services in ways that might generate benefits for system developers and their clients. If any or all of the service lenses might genuinely help in analyzing and designing systems, failure to pursue this opportunity would be unfortunate and wasteful.

In reality, the answer to question #1 hinges on the answer to question #2, which is about identifying lenses that could make a difference. SA&D should adopt any lens that has a high likelihood of generating better results. On the other hand, if adopting service lenses would not matter, there is no reason to proceed in that direction.

Thus, the real issue is whether the use of any of these lenses should or actually does lead to better SA&D results. This is an empirical question that should be pursued.

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