Communications of the Association for Information Systems

Volume 5 Article 11

January 2001

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Recommended Citation
Alter, Steven (2001) "Are the Fundamental Concepts of Information Systems Mostly About Work Systems?," *Communications of the Association for Information Systems*: Vol. 5 , Article 11.
DOI: 10.17705/1CAIS.00511
Available at: https://aisel.aisnet.org/cais/vol5/iss1/11

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ABSTRACT

Audience comments about a debate at ICIS200 [Alter et al., 2001] related to e-business and the fundamental concepts of information systems noted that the debate was undercut by the lack of agreement about what are the fundamental concepts. As a follow-on to that debate, this article proposes a set of fundamental concepts for information systems. While there is no bullet-proof way to prove that a particular set of concepts captures what is truly fundamental within a diverse and rapidly evolving field, the attempt to identify these concepts challenges the reader to ask "If this isn't the way to identify fundamental concepts, what is the way to do that? If these aren't the fundamental concepts, what is a better set of fundamental concepts and why?"

This article's overarching theme is that the fundamental concepts of information systems are mostly fundamental concepts of work systems in general. The article defines "fundamental concept" and discusses various considerations for identifying them. It then proposes a set of fundamental concepts organized in several layers. The first layer concentrates on the elements needed to summarize a work system. The second layer adds concepts that constitute a general vocabulary for describing, understanding, and evaluating work systems. Each concept in the second layer is related to a specific concept in the first layer.

Since an information system is a special case of a work system, every fundamental concept of work systems should at least apply to information systems and might be a fundamental concept of information systems. Similarly for work system projects and information system projects, both of which are also special cases of work systems. The article argues that the fundamental concepts of work systems should be viewed as fundamental concepts for all three special cases and then concludes with a number of questions about that the reader might want to consider concerning the approach the article takes and the particular fundamental concepts that are identified.

Keywords: work system, information system, information system concepts, systems approach, information system education, information system framework

I. INTRODUCTION

In 1988, the Framework for Information System Concepts (FRISCO) task group within Working Group 8.1 (Design and Evaluation of Information Systems) of the International Federation for Information Processing (IFIP) issued a manifesto that said,

> "There is a growing concern within IFIP WG 8.1 about the present situation, where too many fuzzy or ill-defined concepts are used in the information system area. Scientific as well as practice-related communication is severely distorted and hampered, due to this fuzziness and due to the frequent situation that different communication partners associate different meanings with one and the same term. There is no commonly accepted conceptual reference and terminology to be applied for defining or explaining existing or new concepts for information systems". [IFIP, 1988]

Ten years and several conferences later the FRISCO task group issued its final report which "provides a reference background for scientists and professionals in the information system area comprising a consistent and fully coherent system of concepts and a suitable terminology that enables them to express themselves about matters in the information system area in a structured and well-defined way." [Falkenberg et al, 1998, p.2] Appendix 1 presents the concepts used in the FRISCO report's second chapter to explain the committee's "line of reasoning" about information systems. Appendix 2 presents the report's fundamental concepts as identified and numbered in the summary of its third chapter. Even without the explanation in the full report, a glance at the concepts would reveal that they might be understandable to computer scientists and organization theorists, but probably would not be readily understandable or usable by most business professionals or even the many system developers who lack rigorous computer science degrees.

Fast forward to ICIS 2000, whose conference theme was "Fundamental Concepts for the New Millennium." This theme inspired a debate about whether the trend toward e-business calls for changes in the fundamental concepts of information systems. The audience was invited to vote on two debate propositions and to submit written comments in response to the debate. Some of the written comments stated that fundamental concepts were not really discussed in the debate and that there is very little agreement in the IS field about what those fundamental concepts are [Alter et al., 2001] .

Twelve years had passed from the time of the FRISCO manifesto, but the audience comments about a debate at ICIS 2000 convey the same message as the FRISCO manifesto of 1988. The theme of ICIS 2000 was supposed to be about fundamental concepts and we had a debate related to fundamental concepts, but some members of the audience complained that there is no agreement about these concepts and that we barely discussed them.

This article proposes a set of fundamental concepts (FCs) of information systems that differs markedly from the FCs proposed by the FRISCO report. The FCs in the FRISCO report were directed toward IS developers and tried to provide a combined set of social science and computer science concepts that they could use. In contrast, the FCs in this article are directed toward business professionals who need to understand business situations involving information systems. I personally believe that IS developers would also benefit greatly from using FCs such as those proposed here because attention to these FCs might help them communicate more effectively with business professionals and with one another.

This article's overarching theme is that the FCs of information systems are mostly FCs of work systems in general, rather than information systems per se. Both the theme and the FCs emerge from a "common denominator" metaphor that identifies information systems and projects in organizations as special types of "work systems" that exist to support, modify, or create other work systems. Although a complete discussion of this topic would fill a book, many of the ideas were discussed in a previous *CAIS* article, "A General, Yet Useful Theory of Information Systems" [Alter, 1999], which is organized in terms of 14 propositions focusing on the relationship between information systems and related work systems.

This article is organized in the following sections:

III. The First Layer: Ten Fundamental Concepts for Describing, Understanding, and Evaluating a Work System In addition to system and work system, these concepts are the elements of a work system framework that includes customers, products and services, business process, information, technology, infrastructure, and context.

IV. The Second Layer: Additional Fundamental Concepts for Describing, Understanding, and Evaluating a Work System A second layer of FCs provides the basic vocabulary for analyzing a particular work system.

V. Fundamental Concepts for Describing, Understanding, and Evaluating Information Systems This section asks whether the FCs for work systems are actually FCs for information systems and whether additional FCs are also needed for information systems.

VI. Fundamental Concepts for Work System Projects Since projects are a special type of work system, FCs for work systems in general should at least apply to projects. This section asserts that they are FCs for work system projects but that the characteristics of projects call for some additional FCs.

VII. Fundamental Concepts for Information System Projects This section asks whether the FCs for work system projects apply for information system projects or whether additional concepts are needed.

VIII. Conclusion

References

Appendices

II. CONSIDERATIONS FOR IDENTIFYING FUNDAMENTAL CONCEPTS

A 1993 effort to revise *MIS Quarterly's* keyword classification scheme for IS research [Barki, Rivard, and Talbot, 1993] resulted in a scheme still used by *MIS Quarterly* today. It contains 1,300 keywords of which 175 were additions to the previous version published in 1988. Assume we were to start again with a different focus. Instead of keywords for IS research, the goal is fundamental concepts of information systems. Imagine we started with a list of 10,000 important IS concepts and tried to pare that down to 5,000 and then 1,000, 500, 100, and perhaps 50. Ideally this process of elimination would identify the truly fundamental concepts and would show their relationship to other important concepts that are less fundamental. Assume we went all the way to 10 concepts or 5 or 3. The initial list of 10,000 concepts was certainly too long, but at some point, perhaps at 100 or 25 or 5, the list would be so short that it would not be

helpful in describing or analyzing situations of interest. An ideal list of fundamental concepts would attain the right compromise between the extremes. It would include enough of the right concepts that it would genuinely help in describing and analyzing most situations of interest.

Selecting concepts that qualify as FCs starts with the definition of fundamental concept.

> *Fundamental concepts* are the basic domain-related vocabulary used to describe, analyze, and evaluate the phenomena within the domain from a particular perspective.

DOMAIN AND PERSPECTIVE

According to the definition of FC, the domain of knowledge and the perspective for viewing the domain are important determinants of whether a particular concept qualifies as an FC:

Domain

The domain is the area of knowledge the FCs describe. The field of information systems contains a number of potentially separable domains, such as information technology, operation and evaluation of information systems, processes related to building and maintaining information systems, and governance of IT. FCs for any these domains might overlap with FCs for the others, but one would not expect the FCs for all of these domains to be identical. Furthermore, each of these domains might be subdivided into smaller domains (such as object oriented programming, encryption, or organizational change), each of which has its own FCs that may or may not be FCs for information systems in general. The two domains of interest in this article are:

1. describing and evaluating information systems and

2. building and maintaining information systems.

Perspective

The FRISCO report was clear about its perspective when it asked, “Are we, as developers of information systems, basing our reasoning and our basic concepts on a proper foundation?” [Falkenberg et al, 1998, p. 14]. The preamble of the report recognized the importance of perspective by saying that information systems are addressed by “different scientific disciplines or ‘cultures’, in particular computer science and social sciences Too little communication among these different ‘cultures’ has taken place. While developing computerized information systems, too many computer scientists have neglected the essential organizational, cognitive and social aspects of information system development, and have hardly been aware of the central role of information and communication in organizations. This has often resulted in partial or even total failure of development projects of computerized information systems. On the other hand, social and organizational scientists have often been unaware of the importance of considering (the most essential) formal aspects of information system development and thus wandered aimlessly where more precision would have helped them out.” [Falkenberg et al, 1998, p.2]

Several recent articles on IS effectiveness and IS success emphasize the importance of the perspective used in evaluating success. Grover et al. [1996, p.182] list four perspectives for evaluating information systems:

• Users	• IS personnel
• Top management	• External entities

In a literature survey titled “Dimensions of Information System Success” Seddon et al [1999] identified five different perspectives for evaluating IS effectiveness:

Outside observer	Stakeholder	Group
Manager or owner	Country	

The importance of perspective in understanding what basic terms mean was illustrated by an article [Alter, 2000a] that looked at how ten *CAIS* articles from May to November 1999 used eight common terms (system, user, stakeholder, IS project, implementation, reengineering, requirements, and solution) and found that the terms had different meanings when used from different perspectives. The term "system" might mean a work system, information system, or software; the term "implementation" might mean making an algorithm run on a computer or the process of achieving a significant change in a business process in an organization; "user" might refer to hands-on users, people who receive information, or managers whose organizations use information systems.

POSSIBLE CATEGORIES OF FUNDAMENTAL CONCEPTS

Individual FCs for information systems might fall into any of the following categories:

Components

These FCs identify components and groups of components within systems. In effect, these are like the nouns of a language about systems.

Functions

These FCs identify different types of functions or operations performed by systems or upon systems. In effect, functions are like the verbs of a language about systems. Note that a technique (like object oriented programming or management by objectives) is a particular way to perform a function. Techniques are very important, but the functions themselves are more fundamental because techniques typically define one of many possible methods for performing a particular function.

Characteristics

Terms such as degree of structure and integration describe characteristics concerning how systems or their components operate or how they are deployed in relation to other components or systems. These terms are like the adjectives in a language of systems.

Performance variables

Terms such as productivity and consistency describe how well systems or their components operate. A given performance variable might have many possible measures of performance such as defect rate or shipments per day. Characteristics and relationships are relatively constant, but today's performance might be quite different from tomorrow's. These variables are like the adverbs in a language of systems.

CRITERIA FOR FUNDAMENTAL CONCEPTS

Whether or not a term qualifies as an FC within a particular domain and perspective depends on the term's clarity, teachability, focus, applicability, and durability.

Clarity

The meaning of an FC should be reasonably clear to the people who use the selected perspective to think about situations within the domain. This criterion implies that the terms "implementation" and "user" might qualify as FCs for looking at information systems from particular perspectives even though their meanings from different perspectives might be different.

The use of "reasonably clear" instead of "totally clear" or "100% defined" might seem odd, but even "reasonably clear" is a fairly tough standard if one looks at inconsistencies between definitions and examples of terms such as decision support system, expert system, e-business, and the new economy. For example, a careful look at many systems cited as DSSs or expert systems would probably

show that they don't conform to the tighter definitions of these terms and that the looser definitions fail to distinguish DSS and expert systems from other types of systems.

Teachability

It should be relatively easy for the intended users (e.g., programmers or business professionals) to learn and use the FCs related to their perspective on a domain they care about. For example, a business professional's FCs related to building and maintaining information systems should be understandable to people who do not have computer science degrees. Similarly, FCs for IT professionals should be readily understandable and usable by people who do not have degrees in social science or philosophy.

Focus

FCs are a selected subset of language that is particularly useful for thinking about situations within a particular domain. For example, the everyday terms "information" and "technology" might be FCs for information systems because they are so pertinent to understanding situations involving these systems. On the other hand, the terms "nutrition" and "sleep" would not be FCs for information systems even though every IS user needs nutrition and sleep and even though these two concepts might be particularly relevant to certain situations in which a lack of nutrition or sleep might affect a particular IS user's ability to perform that role.

Applicability

FCs should be directly applicable in describing, analyzing, or evaluating most of the situations that are of interest within the domain. While special cases and system categories are often important for understanding specific situations, the special cases are usually defined in terms of FCs and are therefore not the FCs themselves. For example, the term "standard" might be an FC related to

information systems, but TCP/IP would not be an FC, or if it were, it would be viewed as less fundamental than "standard."

Durability

True FCs tend to persist in time. Today's FCs are probably similar to those of 1980 and will probably be similar to those of 2020. Looking again at the above example for applicability, the term "standard" was applicable long ago and will be applicable in the future, whereas TCP/IP might be ancient history by 2020.

Summary

This section defined the term fundamental concept, argued that FCs are related to a particular domain and perspective, mentioned possible categories of FCs, and identified criteria for deciding whether a particular term is an FC. The terms used to discuss FCs (fundamental, concept, component, function, characteristic, performance variable, etc.) were not viewed as FCs on their own right, but rather as part of everyday language. The authors of the final FRISCO report and others who are more concerned with complete rigor might have treated these terms as FCs or might have provided a more careful definition of those terms. (See Appendix 1.)

The next section introduces the fundamental concepts I propose.

III. THE FIRST LAYER: TEN FUNDAMENTAL CONCEPTS FOR DESCRIBING, UNDERSTANDING, AND EVALUATING A WORK SYSTEM

This section begins the discussion of why FCs for information systems are mostly FCs for work systems. It starts by defining work system, noting that information systems (and projects) are actually work systems, and presenting a work system framework that contains eight elements needed to describe and evaluate a work

system. These eight elements plus the terms “system” and “work system” are my suggestions as the first ten fundamental concepts for understanding information systems.

#1: SYSTEM

A system is a set of interacting components that operate together to accomplish a purpose. “One of the most commonly voiced complaints in systems is that general systems theory is so general that it cannot be applied in any formal way.” [Kendall and Kendall, 1993, p. 161] The concept “work system”, discussed next, reduces the generality of “system” by providing more focus, thereby creating a genuinely useful way of looking at most systems in organizations.

#2: WORK SYSTEM

A work system is a system in which human participants and/or machines perform a business process using information, technology, and other resources to produce products and/or services for internal or external customers. [Alter, 1999] Typical business organizations use work systems to obtain materials from suppliers, produce and deliver end products, find customers, create financial reports, hire employees, coordinate work across departments, and perform many other functions.

Information Systems (And Projects) As Work Systems

Information systems (and projects) are work systems on their own right since they consist of human participants and/or machines performing a business process using information, technology, and other resources to produce products and/or services for internal or external customers.

The Work System Framework

Figure 1 shows a graphical representation of a framework that can be used to summarize any work system. [Alter, 2002] A framework such as this one organizes the FCs, shows how they are related, and provides guidance in how

they can be used together when thinking about a particular situation within the domain. Without a framework, a list of FCs is like a glossary that provides no way to see how the terms are related to one another and which are more fundamental.

The work system framework defines the eight elements that should be included in even a superficial understanding of a work system (which might be an information system or a project in an organization). In Figure 1, the trapezoid surrounding the business process, participants, information, and technology indicates that those four elements constitute the system performing the work. The work system's outputs are the products and services received and used by its customers. Including the products and services and the customers in the

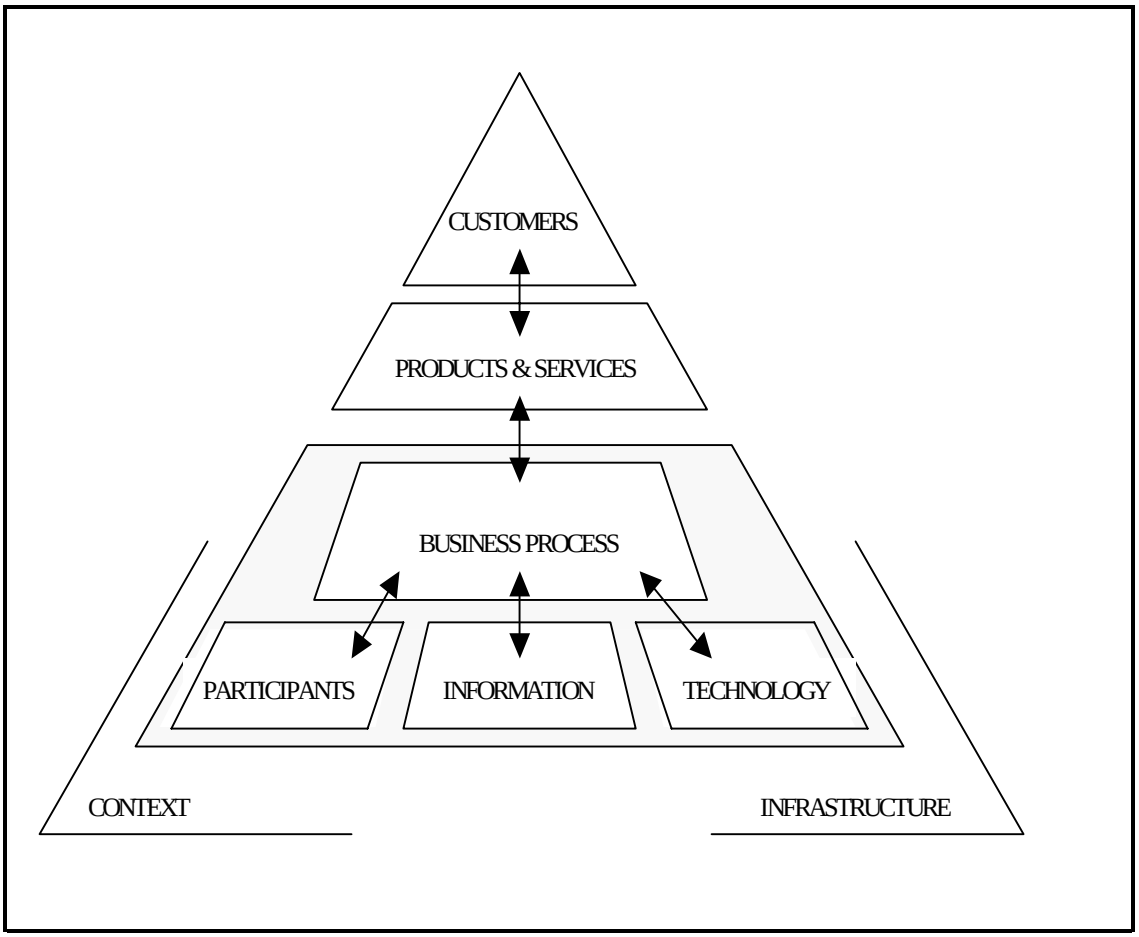


Figure 1. The Work System Framework [Alter, 2002]

picture even though they are not part of the system reflects the notion that a work system exists to produce outputs for its customers. Regardless of whether a work system is operating consistent with its initial design or its formal documentation, it is not fully successful unless it generates products and services the customers want. The framework also includes the related infrastructure and context that are outside of the work system. Remember that any system's operation and success depends to some extent on external factors beyond the direct control of its participants and managers.

The eight elements of the work system framework are FCs #3 through #10:

#3: CUSTOMERS

Customers are the people who receive, use, and obtain direct benefits from the products and services produced by the work system. They may include both external customers who receive the organization's products and/or services and internal customers inside the organization.

#4: PRODUCTS AND SERVICES

Products and services are the combination of physical things, information, and services that the work system produces for its customers. The work system exists to produce these products and services.

#5: BUSINESS PROCESS

A business process is the set of work steps or activities performed within the work system. These steps may be precisely defined in some situations or relatively unstructured in others. In some situations, the same steps may be performed differently based on differences in the participant's skills, training, and interests.

#6: PARTICIPANTS

Participants are the people who perform the work steps in the business process. Some participants may use computers and information technology extensively, whereas others may use little or no technology.

#7: INFORMATION

The specific information used by the participants to perform their work. Some of the information may be computerized, but other important information may never be captured on a computer.

#8: TECHNOLOGY

Technology includes the hardware, software, and other tools and equipment used by the participants while doing their work. The technology considered to be within a work system is dedicated to that system, whereas technical infrastructure is technology shared with other work systems.

#9: INFRASTRUCTURE

Infrastructure is shared human, informational, and technical resources that the work system relies on even though these resources exist and are managed outside of the work system. Infrastructure typically includes human infrastructure such as support and training staff, information infrastructure such as shared databases, and technical infrastructure such as networks and programming technology.

#10: CONTEXT

Context is the organizational, competitive, technical, and regulatory realm within which the work system operates. These external factors affect the system's

performance even though system does not rely on them directly in order to operate.

RELATIONS AMONG THE CONCEPTS

Note that the term “work system” is different from business process, business function, organization, and other terms commonly used to describe business operations. A work system is smaller than an entire organization or business function because organizations typically contain multiple work systems and operate through them.

On the other hand, a work system is larger than a business process because it explicitly includes the participants, the information, and the technology. Looking at the entire work system does not diminish the importance of the business process, which is viewed as the core of the work system. Considering the entire work system is useful, however, because the same business process can be performed with drastically different levels of efficiency and effectiveness depending on who does the work and what information and technology they use. For example, the best programmers are many times more productive than mediocre programmers. [Yourdon, 1992] The same may be true of the best salespeople, fashion designers, and athletes. Just as different participants might (or might not) produce different results when performing the same process, different (or better) information or technology might or might not affect the results generated by a business process.

Looking at the entire work system also may help in seeing whether the business process actually operates as it was designed. In some cases the difference between the idealized business process (how it was designed) and the work that actually occurs (the real business process) stem from a mismatch between the idealized business process and the participants. For example, a Web site user who is both the customer and a participant in a self-service process may be

unable or unwilling to follow the designer's intentions. Aside from serving people with different knowledge levels, the site might also have to support different business processes related to different goals for using the site.

ISSUES ABOUT THE FIRST TEN FUNDAMENTAL CONCEPTS

As identified above, the first ten fundamental concepts include: system, work system, customers, products and services, business process, participants, information, technology, context, and infrastructure. This view of the most fundamental concepts came from a long-term project to develop a method that business professionals could use to understand systems for themselves (i.e., without requiring the help of a consultant at every step). An earlier version of these ideas was published in Alter [1995][1].

Here are some of the issues in trying to identify the first ten fundamental concepts:

Where Does "Fundamental" Start?

The organization of the FRISCO report reveals some of the difficulties of dealing with this question. Chapter 2 of the report is called "A Line of Reasoning about Information Systems." It explains why the report recommends that "the community at large [should] expand from its strong data and information orientation towards a broader view including human communication and its effects in terms of actions in organizations." [Falkenberg et al, 1998, p. 24] Appendix 1 of this article lists the concepts (mostly related to organization and communication) that Chapter 2 of the FRISCO report seems to view as the preliminary concepts needed to provide the rationale for its FCs. These preliminary concepts include organization, system, goals, added value, actions, resources, actors, actands, state, and many others.

[1] The paper appeared in the Proceedings of a 1995 conference organized by the FRISCO task group within IFIP 8.1. It seemed to have little or no bearing on the final FRISCO report (which had different goals, as mentioned in Section I).

The FCs that follow from these concepts are explained in Chapter 3 of the FRISCO report and presented in a highly formalized, but unfriendly format in Chapter 4. Appendix 2 of this article lists those FCs and shows that they start with thing, predicator, predicated thing, relationship, set membership, elementary thing, composite things, and so on. A great deal of time and care went into producing rigorous definitions presented in the report. Whether these definitions are genuinely helpful for describing or analyzing real world systems is, in my opinion, questionable.

Why Start With FCs of Work Systems Instead of FCs of Systems in General?

Textbooks on information systems often make at least passing reference to general system terminology such as boundary, environment, input, output, and feedback. Given the goal of providing a minimum set of FCs that business professionals can learn and use readily, it seemed more effective to start by assuming that some of the general systems terms are just part of everyday vocabulary and that FCs should have a specific meaning in relation to the framework. Based on this view, the concepts of inside and outside (hence "boundary" and "environment") are very important but don't have to be defined explicitly. The trapezoid in the work system framework (Figure 1) defines what is inside the system, and two of the other terms ("context" and "infrastructure") are more effective than "environment" for identifying the pertinent aspects of what is outside the work system. Similarly, the terms "input" and "output" seem useful for describing computer programs but not so useful for describing work systems. For example, assume that someone in an office participates in three different work systems. What part of that person's attention (and what percentage of the depreciation on that person's chair) is considered an input to each of those work systems, and how should it be described? "Products and services" covers the outputs in a more useful way, just as participants, information, and technology (plus the "other resources" mentioned in the definition of work system) cover the inputs in a more useful way.

Customers

Although every work system should have at least one customer, many work systems have both internal customers (within the enterprise) and external customers. "Customers" seemed to be the fundamental concept, whereas internal customers and external customers belong in the next layer of important concepts. Even the term customer has some ambiguity, however. In addition to the people who directly use or benefit from the products and services, "customer" is sometimes construed to include other stakeholders, especially people who do not receive or use the products and services but do authorize or pay for them.

Products and Services:

What term(s) should denote the outputs produced by a work system? The term "output" has too many connotations related to computers. In earlier versions of the work system framework the output was called the "product" but the fact that this product could be a service caused confusion since the distinction between products and services is used frequently. If the product went to an external customer it might be considered an "offering" but offering didn't seem satisfactory for internally directed work systems.

Business Process

Including the business process says that the systems we are talking about actually do have a business process that is at least somewhat definable. (It doesn't have to be totally structured.) This business process is meant to be the one that actually occurs, rather than a theoretical or idealized business process that is defined in a manual but actually occurs only 75% of the time.

Participants

Participants are the people who perform the steps in the business process. It is not clear whether the managers of the organizational unit should be included as participants because managers may or may not perform business process steps. The term participant was chosen instead of "user" because business process

participants may have different roles, some of which may not involve technology use at all. Furthermore, from a participant's viewpoint, issues about being a user of a particular technology are only a subset of the issues about being a participant in the work system. In many cases, issues about being a user of a particular technology are minor compared to work system factors such as the organization and management of work, working conditions, and incentives. Markus and Keil [1994] illustrate this point in a case study of an expensive information system improvement project that had almost no impact.

Information

Based on the frequently cited distinction between data and information one might wonder whether data or information is the fundamental concept. Data might be the fundamental concept for a computer scientist looking at how computer programs process data, but information is the fundamental concept within a work system because the information cited is actually used or created by the business process; irrelevant data is therefore not included in the description of the work system. The information might include hard information (precisely defined, often computerized) or soft information (poorly defined, typically non-computerized, but often important).

Technology

Because there is no reason to assume that information technology is the only important technology in a work system, the fundamental concept "technology" includes information technology and any other technology that matters within the work system. For example, in the widely publicized Denver International Airport baggage system fiasco, part of the technology is the physical methods for moving baggage between locations in the airport. [Montealegre and Keil, 2000]. Note that technology and the business process are treated as separate elements even though some social scientists might view the business process and technology as inseparable.

Infrastructure

Infrastructure includes technical infrastructure, information infrastructure, and human infrastructure. The distinction between technology within the work system and technical infrastructure is admittedly dicey because different people might define the boundary differently. Explicit inclusion of external infrastructure is usually important because the operation of most work systems relies on technology, information, and human services that are external to the work systems themselves. For example, technical infrastructure such as the Internet is essential for the operation of an e-commerce work system even though it is not owned or controlled by the work system participants or their managers or their organization. It is always possible to expand the definition of a work system to include all of the otherwise external technology, information, and human support services that it relies on, but doing such an expansion would make many work systems so large that they could not be analyzed effectively.

Context

Context is everything that matters enough to be mentioned even though it is outside of the work system and does not contribute directly to the work system's operation. The term context attempts to be a bit more specific than the term environment that is often used to denote whatever is outside a system's boundary. The importance of the context runs throughout the frequently cited story of the Challenger disaster, in which a rocket launch was not called off even though engineers knew the that sub-freezing ground temperatures might cause catastrophic failure of a critical component. The context included funding disputes, delays, and political pressures that influenced the launch decision.

How Do the First Ten Fundamental Concepts Apply to Information Systems?

An information system is a special case of a work system. It is a work system whose business process is devoted to some combination of capturing, transmitting, storing, retrieving, manipulating, and displaying information. In the Denver International Airport's baggage system, for example, the story is about a

work system for moving baggage. That work system happens to contain an information system that captures, transmits, stores, retrieves, manipulates, and displays information related to baggage items, baggage carts, and other important aspects of the work system. The work system framework can be used to describe or analyze the entire baggage system. Since the information system is a work system on its own right, the work system framework can also be used to look more specifically at just the information system. In other words, the first ten FCs are a starting point for looking at both the entire baggage system and at the information system it contains.

The first ten FCs are applicable in a similar way in understanding work systems involved in e-commerce. It is reasonably easy to superimpose the work system framework on work systems for ordering inventory, receiving shipments from suppliers, warehousing items, packaging items for shipping, and shipping the packages to customers. All of these work systems contain or share information systems that can be described using the same framework.

The work system framework can also be used to look at the Web site an e-commerce customer uses. In these situations the customer is performing a self-service business process constrained by the logic of the Web site. The aesthetics and technical features of the Web site are obviously important, but from a business perspective the main issue involves how effectively the customer performs a self-service process. In effect, the customer is a work system participant who uses the Web site to accomplish specific objectives. Thinking about the Web site in work system terms immediately raises issues about different goals that different customers might have and the different business processes they might use to accomplish those goals. An e-commerce site that might be wonderful for the business process of ordering a frequently used personal item might be stunningly ineffective for the business process of figuring out what to order as a gift for someone else. The issue is not about technology,

but rather, about two different work systems that happen to use the same Web site.

IV. THE SECOND LAYER: ADDITIONAL FUNDAMENTAL CONCEPTS FOR DESCRIBING, UNDERSTANDING, AND EVALUATING A WORK SYSTEM

The first ten FCs can be used to summarize a particular work system that is being discussed or studied. A second layer of FCs provides the basic vocabulary for analyzing problems and discussing alternatives related to a particular work system. Those FCs are organized around the term "work system" and the eight elements of the work system framework. The primary goal in proposing the second layer of FCs is to identify the types of terms that should be included. Whether a particular term or one of its synonyms was selected is not as important as whether the right kinds of terms are included.

To make this article easier to read, the second layer FCs for describing and evaluating a work system are presented in Appendix 3 in tabular form , with a separate table for "work system" and each of the eight elements of the work system framework. In these tables each FC is classified as a component, function, characteristic, or performance variable. Most of the FCs in the second layer fit cleanly within these categories but some do not fit very well. Because the first layer of FCs consists of 10 FCs, the second layer is numbered sequentially starting at #11 and going to #106. While it is not very important whether a better set of FCs would number 98 or 112, the numbering shows that the proposed set of FCs are far more than 30, for example, and that 22 of these FCs are related to the business process.

To demonstrate that the FCs listed are at least relevant to the description and evaluation of a work system, the second column in the tables in Appendix 3 presents hypothetical one-sentence excerpts from a hypothetical case study. Each sentence either includes the FC in the first column explicitly or uses the

concept without using the term. The case is about a company called Fruitless Pies, Inc. (FPI), whose executives are discussing a new product idea involving customized pies fashioned to regional events and tastes. The *work system* in this case extends from determining customer requirements through acceptance of shipments. The *business process* includes steps for defining the customer requirement, committing to deliver, manufacturing the pies, packaging them, and delivering them. The *products and services* center around the customization and delivery of pies. The *customers* are distributors and restaurants. The *participants* include customers, sales people, and manufacturing, packaging, and delivery personnel. The *information* includes product options, current and past orders, inventories, staffing, and customer payment histories. The *technology* includes ovens, manufacturing software, sales software, laptop computers, a national intranet, and local servers. The *infrastructure* includes the corporate computers and the Internet. The *context* includes increased competition, an unfavorable report from OSHA about work conditions in the factory, and a recent fad of complaining about nutrition-free foods.

The purpose of the one-sentence excerpts from the hypothetical case is to demonstrate that the FCs provide a plausible vocabulary for describing, understanding, and evaluating a work system. FPI's managers and analysts surely wouldn't issue a report organized as a single sentence or paragraph per FC and surely would go into more depth on topics such as how the business process operates, what the customers really want, and exactly what additional information is needed. Nonetheless, the sequence of hypothetical excerpts does provide a relatively painless way to visualize how the proposed FCs can be used for describing and evaluating a work system and to see whether the FCs are important.

There is no way to prove that the proposed set of FCs is perfect, but you can look at Appendix 3 to decide whether they are at least plausible as a set of FCs

for evaluating and describing work systems from the perspective of a business professional. To do so:

1. *Use the criteria cited earlier:* Although the terms are applied in an example instead of being defined and discussed in depth (which would have made this article much longer), do you believe they satisfy the criteria of clarity, teachability, focus, applicability, and durability?

2. *Consider other situations*: Imagine a different case about a totally different work system in some other organization. Perhaps it is a work system for determining insurance renewal rates or hiring new engineers at a semiconductor firm or performing a monthly accounting close at a consulting company. Would most of the FCs be relevant in those or other situations? Which would be irrelevant or at least unimportant in most cases? What other terms might be more fundamental?

3. *See whether each FC is important in the IS literature*: These are posed as FCs of work systems in general, but one informal test of whether they are important is to try to recall several books or articles in the IS literature that focus on each of the second layer FCs. The existence of publications related to a concept does not guarantee that it is an FC, but at least indicates that some authors and editors think it is reasonably important to the IS field.

V. FUNDAMENTAL CONCEPTS FOR DESCRIBING, UNDERSTANDING, AND EVALUATING INFORMATION SYSTEMS

The previous sections presented a first layer of 10 FCs for describing, understanding, and evaluating work systems plus a second layer of 96 additional

concepts, each related to an FC in the first layer. All of these FCs apply to work systems in general.

Figure 2, which parallels previous discussions of the inheritance of success factors from work systems to information systems and projects (Alter [1999], Figure 3 and Alter [2000c]), illustrates how the concepts that are FCs of work systems should apply to information systems and projects. The fact that an information system is a special type of work system implies that the first layer FCs included in the definition of work system (customers, products and services, business processes, etc.) at least apply to information systems and are probably FCs as well. Many of the second layer concepts also apply in obvious ways, such as #11, goals; #12, constraints; #13, management of the work system (in this case, the information system); #16, measures of performance; and so on.

The fact that concepts #11, #12, #13, and # 16 apply to information systems does not necessarily imply that they are FCs of information systems, however. For example, consider the work system FCs in Appendix 3 related to physical things. These include #23, physical products vs. information products (as components of the products and services); #36, manipulating physical objects (as part of the business process); and #83, non-computer technology (as part of the technology). These concepts are not especially important for information systems that are completely Web based, that produce no physical outputs, and that are not related to physical things, even though it is always possible to print a Web page. On the other hand, many information systems do produce paper outputs that have to be compiled and delivered physically, and some of the related technologies for compiling and delivering these physical things may not be computerized at all. Thus, even though work system FCs #23, #36, and #83 apply to many information systems it is not obvious that they should be considered FCs of information systems. A similar question arises for work system FCs directly related to work system participants, such as #55, mastery of

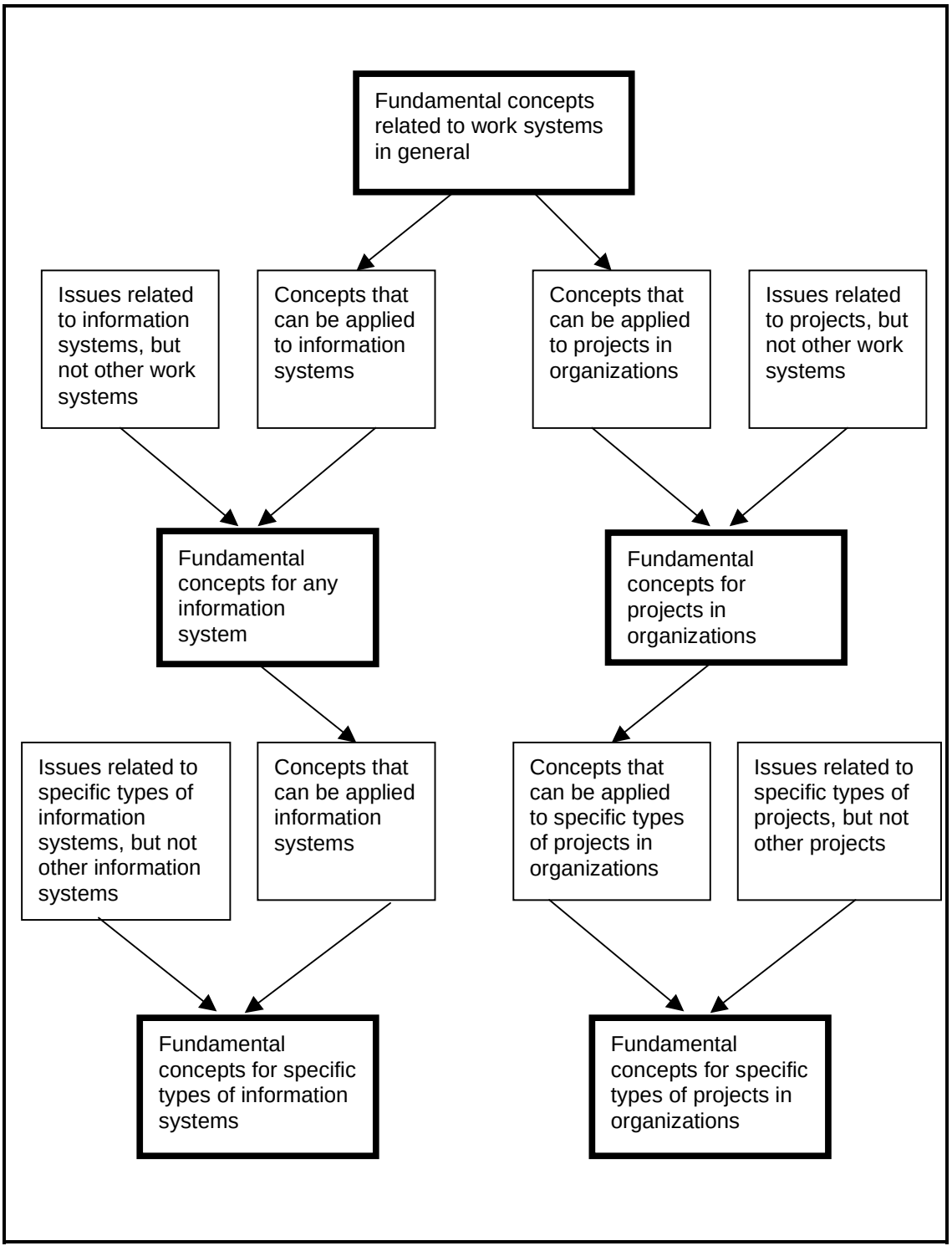
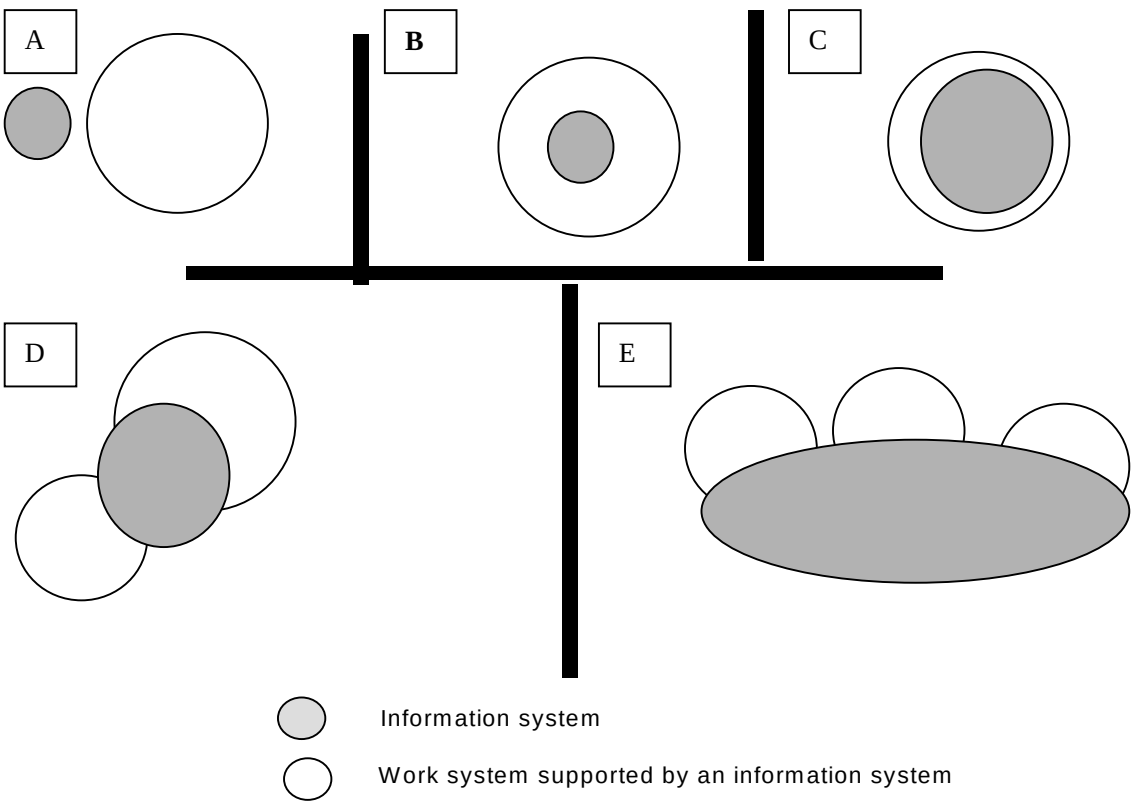


Figure 2: Relation Between Fundamental Concepts of Work Systems and Fundamental Concepts of Information Systems and of Projects.

necessary skills; #56, congruence between incentives and goals of the work system; #57, fit between personal characteristics and work system characteristics; and #58, individual productivity. These concepts apply to all information systems that have human participants, but might or might not be considered FCs for information systems even though the IS literature contains many publications that focus on these topics.

These objections notwithstanding, in my opinion it is reasonable to treat all of the FCs for work systems as FCs for understanding information systems from a business professional's viewpoint. A direct reason for this conclusion is that all FCs of work systems do apply to information systems and most FCs of work systems are genuinely significant in describing, understanding, and evaluating most information systems. An indirect reason is that describing, understanding, and evaluating most information systems from a business professional's viewpoint requires describing, understanding, and evaluating the work system(s) that the information system supports or automates. For example, someone looking at the information system within the Denver International Airport's baggage system would surely want to understand the baggage system itself.

Figure 3 illustrates some of the possible types of overlap between information systems and related work systems. The earliest computerized information systems were typically used though patterns A, B, and C in Figure 3. As real time access to shared databases became more common, information systems increasingly took on additional forms of overlap such as D and E. Regardless of which form of overlap applies to a particular situation, the fact that the overlap exists implies that FCs needed to understand work systems related to any information are also needed to describe, understand, and evaluate the information system itself. The fallacy of focusing on the information system without understanding the work system has been called the "Siamese twins problem," which refers to whether it makes sense for information system



A. Comparatively small IS provides information for a WS but is not part of it. Example: An MIS that collects production data and generates a weekly production summary report for management.

B. Comparatively small IS is a dedicated component of a WS. Example: A real time dispatching system helps workers decide what lot to process next in a factory.

C. WS is primarily devoted to processing information and the IS and WS are almost identical. Examples: billing system, payroll system, loan approval system.

D. One IS overlaps with several separate WSs. Example: An IS for sales call tracking might be used by the sales force for tracking sales progress and by the finance department for financial projections.

E. A large IS supports a number of different WSs and might be larger than any of them. Example: An airline reservation system used for deciding what flights to take, booking reservations, yield management calculations, frequent flyer promotions, etc.

Figure 3: Various Types of Overlap Between Information Systems and Related Work Systems [Alter, 2002]

researchers to emphasize one twin (the information system) while ignoring or downplaying the other (the work system). [Alter, 2000b]

FUNDAMENTAL CONCEPTS OF INFORMATION SYSTEMS BUT NOT WORK SYSTEMS

Figure 2 showed that issues related to information systems but not other work systems may call for additional information system FCs. These additional FCs would not be work system FCs and may not even be concepts related to work systems. Presented next are a few information system FCs that are not work system FCs. These are numbered starting with 107 under the assumption that all the FCs of work systems (11 through 106) in Appendix 3 are also FCs of information systems:

#107 - #112

"Processing information" is work system FC #38 (see Appendix 3). "Processing information" is used instead of "processing data" because a particular work system creates or uses only what is pertinent to its operation (hence, information rather than data). The processing of information (or data) involves one or more of six basic functions: #107, capturing information; #108, transmitting information; #109, storing information; #110, retrieving information; #111, manipulating information; #112, displaying information.

#113: Information System

"Information system" is an FC of the domain "information systems" because it defines what the domain contains, namely, those work systems whose business process is devoted to some combination of capturing, transmitting, storing, retrieving, manipulating, and displaying information. The definition of an information system is potentially useful to business professionals because it highlights the fact that software vendors sell software (an information system component) rather than information systems, which also include the business

process, participants, and the information in the situation being described or analyzed.

#114: Difference Between an Information System and the Work System(s) It Supports or Automates

This distinction is useful to business professionals because it helps them avoid confusion about what system is being discussed at any particular time. Someone talking about CAD or CRM or ERP may be talking about a software product, about an information system in an organization, or, as Markus [2000] noted recently, about a philosophy of operations.

#115: User

In the domain of information systems, the users include

1. work system participants who enter data and transactions,
2. work system participants who manipulate and analyze data, and
3. work system participants who use information, whether or not they obtain it through computerized interfaces. In some cases user is even construed to include the managers whose organizational subordinates are the hands-on users of the technology or information. (See for example “The Case of/for the Missing User." [Sutter and Olfman, 1999].)

The range of meanings for the term “user” is one of the common confusions in this field. Perhaps the term user is so unclear that it should be split into several different FCs such as “technology user” and “information user.”

#116: User Interface

The interface is the part of a technology that is devoted to interacting with users of that technology. The graphical user interface was an important advance beyond the earlier interfaces based totally on keyboard commands, but (in my opinion) GUI is not a fundamental concept at this level because other important types of interfaces exist (e.g., keypad, voice recognition) and others will probably be developed in the future.

#117: Voluntary vs. Mandatory Usage

A lot of attention has gone toward understanding factors that determine whether and to what extent information systems are used. A key factor in these studies is whether usage is a mandatory part of a business process or whether it is voluntary and relies mainly on the whims of individual users. An airline reservations agent has no choice about whether to use an airline reservation system, but the CEO of the airline might or might not use a particular information system or model when making a strategic business decision.

#118: User Support

The success of many information systems depends on the extent of the user support usually provided as part of the human infrastructure surrounding the information system.

#119: Technical Support

Keeping the computers and networks running is another part of the infrastructure that makes it possible for information systems to operate effectively.

WHY FUNDAMENTAL CONCEPTS OF IS DO NOT INCLUDE CLASSIFICATION SCHEMES, TECHNIQUES, SPECIAL CASES, AND BUZZWORDS

The information system FCs above do not mention topics such as the Internet, the World Wide Web, URL, TCP/IP, Java, public key encryption, peer-to-peer, DSS, expert systems, customer relationship management (CRM) systems, and enterprise resource planning (ERP) systems. *MIS Quarterly* uses a keyword classification scheme [Barki, Rivard, and Talbot, 1993] that contains only two of these terms, DSS and expert systems. It is not surprising that a 1993 keyword scheme does not include terms describing topics that became more important or were invented later, but it does lead one to wonder about the practicality of

including classification schemes, techniques, and special cases in a set of fundamental concepts. In my opinion topics such as these do not qualify as fundamental concepts because they do not satisfy the criteria for FCs (clarity, teachability, focus, applicability, durability).

Classification Schemes

IS taxonomies usually fail the tests of clarity and durability because they are both poorly defined and fluid. Ten years after someone names and describes a new type of information system, such as DSS, IOS, or EIS, the name still exists but some of the original characteristics are no longer as important or become commonplace. In practice, many information systems, especially the most important ones, contain features and characteristics associated with several different system categories. Furthermore, any particular information system that might fit a particular category today might not fit it tomorrow when additional features are added. For example, in the 1980s I worked for Consilium, a manufacturing software firm that built a complex tracking system for semiconductor manufacturing. The system obviously involved transaction processing, but when we added management reports and data analysis it took on some features of MIS and DSS. When one of our competitors claimed its software was an expert system we responded by producing a rule-based dispatching module so that our sales people could claim that we also had an expert system even though nothing fundamental had really changed about our product.

Techniques

Techniques such as graphical user interface, client/server, and data warehousing are clearly important, but the ideas in these techniques are typically described and understood in terms of more basic concepts. Perhaps terms such as these belong in a subsequent layer of FCs.

Special cases

Although it is important, the Internet could be viewed as one particular network among many others; the World Wide Web is a particular subset of the Internet; a Web browser is a particular user interface tool; TCP/IP is a particular technical protocol and like every other protocol has advantages and disadvantages that will probably lead to its modification or replacement at some point. In my opinion these important special cases should not be viewed as FCs because they are defined in terms of other, more basic concepts that have enough focus to be considered FCs of the field while also being applicable to other situations in the domain.

Buzzwords

It is fun to speculate about ideas such as the new economy, information superhighway, virtual integration, e-business, and e-learning. Although often intriguing in education and sales presentations, terms such as these are not good candidates for FCs because they are difficult to define and often have numerous contradictory meanings and connotations.

VI. FUNDAMENTAL CONCEPTS FOR WORK SYSTEM PROJECTS

The act of building and maintaining a work system is itself a work system because it involves human participants and/or machines performing a business process using information, technology, and other resources to produce products and/or services for internal or external customers. In the case of building and maintaining a work system, the product is the fully implemented and adequately maintained work system. Examples of building and maintaining a work system include creating and maintaining a new work system for managing a large company, creating and sustaining major modifications in a company's sales methods, and building and maintaining a Web-based system for self-service selection and updating of employee benefits options.

We can view building and maintaining a work system (or information system) as a project in an organization. As in the previous discussion of work systems and information systems, Figure 2 shows that concepts related to work systems in general should apply to projects in organizations, but that these concepts may or may not be FCs for projects in organizations. Furthermore, some FCs for projects in organizations may not even be concepts for work systems in general, especially since FCs for work systems in general emphasize a snapshot view for describing, understanding, and evaluating work systems rather than a time-based view inherent in projects.

The FCs for work systems in general (Appendix 3) provide a starting point for finding concepts, and hence potential FCs, related to projects. Consider, for example, the relevance to all projects of the work system FCs cited in the previous discussion of information system FCs, namely, #11, goals; #12, constraints; #13, management of the work system (in this case, the project of building and maintaining a work system); #16, measures of performance.

Other sources for FCs about projects are in the literature related to topics such as management, organizational change, and project management. For example, Lewin provided a very general three phase model of organizational change: demonstrating the need for change and reducing the obstacles to change (unfreezing), shifting behavior and putting the change in place (moving), and stabilizing the organization's new methods and avoiding reversion to the old way of doing things (refreezing). [Lewin, 1951]. Discussions of planned change provide a number of other models, such as the following four phases: exploration, planning, action, and integration. [Cummings and Huse, 1989]. These two models and others from the organization change literature tend to emphasize organizational, psychological, and political issues. They tend to de-emphasize project steps in which substantial project resources are devoted to

the acquisition or creation of office space, hardware, software, and other technology that must be in place before the desired changes can occur.

A slightly different four phase model spans two types of work system projects: those that generate behavior change mostly through influence, power, and re-organization and those in which the behavior change can occur only after acquiring or developing substantial information and physical resources. This model assumes that a work system project goes through four phases: [Alter, 2002].

#120: Initiation

The process of defining the need to change an existing work system, identifying the people who should be involved in deciding what to do, and describing in general terms how the work system and any related information systems should operate differently.

#121: Development

The process of building or acquiring and configuring hardware, software, and other resources needed to perform both the required IT-related functions and the required functions not related to IT.

#122: Implementation

The process of making a new work system operational in the organization. This phase starts from the point when hardware, software, and other necessary resources have been acquired or developed, configured, installed, and tested. It ends at the point when the new work system is truly operational.

#123: Operation and Maintenance

The ongoing operation of the work system plus efforts directed at enhancing the work system and related information systems and correcting bugs.

The four phases (or their synonyms) are fundamental concepts because they apply to a wide range of relevant situations including major planned changes in organizations, moving to new work sites, creation of e-business applications, major modifications of legacy information systems, selection and installation of vendor-supplied application software, and end-user development projects. When used in relation to information system projects (a special case of work system projects), this "common denominator" that covers all work system projects can help in comparing different approaches for system design, system testing, cutover, acceptance testing, and so on. For example, starting with a common denominator helps in understand how terms such as "requirements" might be treated many different ways. They might be determined and recorded formally in the typical methods prescribed for creating an information system, modifying an information system, or selecting a vendor package; they might be implicit, as in development through prototyping without ever defining an explicit requirement; or they might be non-existent, as in selecting a software package without doing a complete analysis and just hoping it fits.

The four phases also help in going beyond the FCs for work systems in general to identify FCs that specifically apply to work system projects. Each of the following FCs is associated with one of the 10 work system FCs in the first layer. The first several are associated with "work system" because they are associated with the entire work system (which is a project in this case) rather than with a specific aspect of the project, such as the business process or information that is used.

#124: Project Plan

The project plan is one of the first products produced in the project and is especially important for achieving project goals related to cost and schedule. Note that previously mentioned FCs related to work systems in general cover various aspects of the plan such as work breakdown (details of the business process), cost, milestones, and assignment of people to tasks. The project

schedule is part of the project plan and therefore does not have to be treated as a separate FC.

#125: Project Budget

The project budget is the staff time and direct and indirect expenses that the project is expected to consume. (Although "cost to the customer" is listed as work system FC #27 in Appendix 3, the project budget has an important specific meaning in regard to projects and is therefore included as a separate FC for projects.)

#126: Anticipated Benefits

Project costs are included in the project budget, but the anticipated benefits are an important part of the rationale for doing the project.

#127: Project Justification

Project justification refers to the formal or informal statement explaining why the project should be undertaken. It considers costs, benefits, risks, the project plan, and other factors.

#128: Sponsor

The sponsor is a special type of customer that funds the project but may not be directly involved in the use of the output (unlike most other work system customers).

#129: Project Deliverables

It is important to mention deliverables explicitly because the completion of deliverables marks the completion of major steps identified in project plans.

#130: Critical Path

The critical path is the set of tasks whose timing and interdependencies determine the earliest time the project can be completed.

#131: Project planning

An important part of any work system project is the creation of a valid plan for the project.

#132: Analysis

Any work system project should include an appropriate amount of analysis effort to understand the current situation.

#133: Design

Any work system project also needs a design effort related to how the new work system will operate, what tools are needed, and exactly how those tools should be configured in order for the work system to operate in that desired manner. Analysis and design are sometimes done simultaneously and sometimes in sequence, but it seems appropriate to separate them because both need to be done.

#134: Debugging

Part of the business process in almost any work system project should include identifying and fixing design errors and other errors that occurred earlier in the project.

#135: Conversion/ Cutover

Part of the business process for almost any work system project should include the actual change from the previous way of doing the work to the new way of doing the work.

#136: Outsourcing

Most work system projects encounter issues about what should be done by the group in charge of the project and what should be outsourced to other groups inside or outside of the enterprise.

#137: Requirements

An important part of the information in a project is the requirements that describe how the new work system and each of its components should operate. The requirements may exist in many forms and with different degrees of formality.

#138: Inertia

Most work system projects encounter some amount of inertia, the tendency for an organization to continue doing things the way they are currently being done or have been done in the past. Overcoming that inertia is often a key challenge. (By choosing inertia as an FC it is unnecessary to include the more emotionally charged term “resistance” as an FC.)

VII. FUNDAMENTAL CONCEPTS FOR INFORMATION SYSTEM PROJECTS

The four-phase model (#120, initiation; #121, development; #122, implementation; #123, operation and maintenance) and the other project FCs mentioned in Sections VI (#124 through #138) apply to work system projects in general. Examining these FCs shows that they or their synonyms are at least relevant to information system projects and are plausible candidates to be FCs for information system projects.

The next question is whether information system projects have some FCs that are not FCs of work system projects in general. A good source for such FCs is articles about software projects, such as Jurison [1999]. Here are a few additional concepts that have special meaning in information system projects and might be considered FCs for those projects even though they are not FCs of work system projects in general:

#139 User Involvement

As with the term user (FC #115 for understanding information systems), the term user involvement has taken on many meanings. For example, an important early article on user involvement [Ives and Olson, 1984] identified six different levels including no involvement, symbolic involvement, involvement by advice, involvement by sign-off, involvement by weak control, involvement by doing, and involvement by strong control. The "user" in these various levels of involvement might include direct users of the technology or information and managers who are not direct users. Regardless of its many meanings, user involvement is fundamental because it is almost always an important issue in information system projects.

#140: Internal Design vs. External Design

"Design" is FC #133 for work system projects. For information system projects it is usually important to distinguish between external design (what the information system will look like to users) and internal design (how it operates internally).

#141: Documentation

Work system projects may or may not require careful documentation, but documentation is an important deliverable of almost any project that creates or modifies an information system that will survive over time. (It might be worthwhile to divide documentation into two FCs, user documentation and technical documentation.)

#142: Programming

Information system projects include programming to create, modify, or configure the software needed prior to the implementation of the information system in the organization. It is debatable whether configuration of application software purchased from vendors should be considered programming, but that leads to a discussion of what programming really means. For example, is the creation of a database application using a database wizard a form of programming or is it

something else? What about the creation of a spreadsheet model? What about the "programming" of a machine tool by guiding it through a desired sequence of motions? Including all of these possibilities under the umbrella of programming implies that programming might or might not involve changes in computer programs.

#143: Unit Testing vs. System Testing

Debugging was listed as FC #134 for a work system project. For an information system project debugging is often more complicated because program modules must be tested and then the entire computerized part of the information system must be tested to make sure that the programs operate together correctly.

#144: Software Change Control

Information systems that include a large number of computer programs written and modified by different people at different times should have formal methods for checking out source code, verifying changes, checking in the modified code, and tracking the changes. Change control is used for larger information systems but still could be considered an FC because the lack of software change control is often relevant to errors in smaller information systems.

#145: Acceptance Testing

Formal acceptance testing occurs in some implementations and others would probably benefit from it.

#146 through #149: Programmers, Analysts, Technical Writers, Trainers

These four job roles are common in information system projects. Other roles obviously exist and it is not clear how many of these should be considered FCs.

#150: Test Data

Testing of programs and entire information systems requires test data. Test data might or might not be included as an FC since formal test data is often not used

for small information systems developed by end users. On the other hand, practices that result in high error rates should not be glorified by omitting concepts that would reduce those error rates.

#151: Programming Languages

Work system FCs #78 through #82 included computer and network hardware, data capture devices, storage devices, display devices, and computer and network software. “Programming languages” is an FC for information system projects because they often require attention in these projects even though they may not be important in work system projects in general. On the other hand, as more and more of programming for information systems morphs into configuration, use of wizards, etc. there might be an argument that programming languages should not be considered FCs of information system projects, but rather, FCs of the separate category of projects that create computer programs.

#152: Database Management Systems

Such a large number of information system projects use DBMS that it should be included as an FC.

#153: Programming Tools

The efficiency of programming depends partially on the programming tools that are available.

FC’s #139 through #153 apply to information system projects in general. Going one level deeper would lead to FCs of particular types of information system projects, such as information system projects that configure and implement ERP software or information system projects that create or modify expert systems related to chemical engineering. Regardless of whether FCs at these additional levels would be of any use they are beyond the scope of this article.

VIII. CONCLUSION

This article attempts to contribute to what has often been a surprisingly unambitious discussion about the basic ideas in the IS field. Much has been said and published about challenges and difficulties related to the multi-disciplinary nature of the IS field. Many complain that there is little agreement about fundamental concepts. Rather few (such as the FRISCO committee) have taken up the challenge of trying to identify the field's fundamental concepts.

Appendix 4 lists all of the FCs mentioned in this article. The first layer FCs for work systems are capitalized. The second layer FCs for work systems are listed directly under the related first layer FC. Additional FCs related to information systems, work system projects, and information system projects are listed under the related first layer FC. In all, 153 concepts are included. Since anyone looking at these Appendices might agree with some specific choices and disagree with others, the article closes with a number for questions that a reader might ask in evaluating both the FCs and the attempt to identify them:

1. Does any of this actually matter? Do we actually lack FCs or is the problem that people in the IS field simply don't care very much about FCs? Appendix 4 is an attempt to write down the FCs that we already know. It is not an attempt to create new concepts. On the other hand, I think that the attempt to identify FCs is important because the lack of agreement about them affects our success as researchers and practitioners, especially when the terms such as system, implementation, and user can have totally different meanings in different published articles and sometimes in the same conversation between people who are trying to communicate with one another.

2. Is the suggested approach for identifying fundamental concepts appropriate or effective? This approach makes sense to me, but many other

approaches are possible. The FRISCO committee was meticulous in identifying basic concepts that were rigorous individually and in combination. I admire their determination and thoroughness, but believe the resulting set of fundamental concepts is not effective for analysis and communication by typical business and IT professionals. In contrast, this article tried to be "reasonably" rigorous by

1. identifying criteria for deciding what is fundamental,
2. recognizing the unclear transition between everyday vocabulary and the specific concepts of the IS field, and
3. providing a framework that organizes fundamental concepts in layers related to work systems in general, information systems, work system projects, and information system projects.

It would be interesting and worthwhile to see other approaches that try to identify a different set of FCs based on other premises and goals.

3. Why focus on the perspective of business professionals instead of IT professionals? I spent much of the 1980s in a manufacturing software firm and left that firm convinced that typical business professionals need better skills and methods for thinking about systems. Anything that would really help them would be a big win, probably a bigger win than developing a slightly better method that IT professionals could use for themselves. Furthermore, many IT professionals find great difficulty communicating with business professionals. Practice using fundamental concepts that business professionals understand could help the IT professionals as well.

4. Are the fundamental concepts of information systems mostly about work systems? Starting from its title, this article argued for a possibly surprising view of the fundamental concepts of information systems, namely, that those concepts are primarily related to work systems in general, not just information systems or information system projects. This article certainly has not proved this thesis is true, but the concepts listed in Appendices 3 and 4 are quite useful in understanding work systems in general, information systems, work system

projects, and information system projects. At a minimum, it is plausible that some of these concepts are fundamental concepts of information systems.

5. Assuming this article's approach makes sense, were the best fundamental concepts chosen? The work system framework was developed over many years based on a combination of taste and experience. Different authors starting from a different framework would probably produce different FCs. Even starting from the same framework they would probably produce some different FCs because different observers often have different views of which specific terms capture particular concepts and issues most effectively. For example, the list of FCs does not include the term "coordination" since I view that as one of several different levels of integration (including common culture, common standards, information sharing, coordination, and collaboration). Other authors would surely think of integration and coordination in a different way.

6. How could these fundamental concepts be validated or improved upon? The entire set of fundamental concepts comes from a multi-year project devoted to developing a practical method that business professionals can use to understand systems for themselves and to communicate about systems more effectively with their business and IT colleagues. One form of validation would involve delivering these fundamental concepts in an appropriate form and testing whether conscious attention to them helps business and IT professionals do a better job of discussing and understanding information systems. Many other ways can be used to improve specific decisions about including or excluding certain terms. For example, the material could be presented to groups of IS researchers or graduate students whose task would be to reduce the number of concepts to less than 60 or less than 20 and to explain why specific terms were included or excluded. The investigators could compare these decisions across groups and could produce an improved list. Another method might involve investigating whether matched groups equipped with competing sets of fundamental concepts performed differently and why. The common point across

these approaches is to avoid leaving the current list of FCs as one person's viewpoint.

7. Does the trend toward e-business call for changes in the fundamental concepts of IS? Audience responses to a debate on this topic at ICIS 2000 [Alter et al. 2001] were a key motivator for this article. My conclusion at this point is that the trend toward e-business may call for some changes in the fundamental concepts of IS, but that any such changes would occur somewhere after the 153 fundamental concepts in Appendix 4, which are probably just as valid for e-business situations as for any other situation involving work systems, information systems, or projects in organizations.

Editor's Note: This article was received on February 17, 2001 and was published on April 29, 2001.

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EDITOR'S NOTE: The following reference list contains the address of World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these references. Readers are warned, however, that
1. these links existed as of the date of publication but are not guaranteed to be working thereafter.
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APPENDIX 1: TERMS FOR REASONING ABOUT ORGANIZATION AT DIFFERENT LEVELS IDENTIFIED BY THE FRISCO REPORT

Before explaining basic concepts in Chapter 3, "Information System Concepts: An Integrated Overview," Chapter 2 of the FRISCO report [Falkenberg et al., 1998] explains the committee's "line of reasoning" about information systems. For example, it says:

> "We are then reasoning about the organisation on the abstraction level of business or organisational relevance and enterprise economy where one is concerned with concepts such as (please read the following text as one long sentence):
> **organisation** - which might be regarded as a
> **system** - for which different directions and aims are set, as
> **goal**s - towards which the organisation strives in order to create
> **added value** - which normally is accomplished by coherent
> **action**s - using certain
> **resource**s - meaning that these actions are performed by
> **actor**s - on
> **actand**s - and where these actions are aiming at changing the

state - within or external to the organisation in a desired way;"

Chapter 2 ends with a "Summary of Concepts" [Falkenberg et al, 1998, p. 25] for reasoning about information systems. The summary notes that some of these concepts are defined explicitly in the subsequent chapters, but others are only used. The concepts for reasoning about information systems are presented in the following order:

1. organisation	11. behaviour	20. intention	29. sentence
2. system	12. norm	21. effect	30. language
3. goal	13. value	22. conception	31. grammar
4. added value	14. rule	23. model	32. reference
5. action	15. responsibility	24. information	33. pattern
6. resource	16. decision	25. knowledge	34. variety
7. actor	17. observation	26. meaning	35. noise
8. actand	18. speech act	27. representation	36. redundancy
9. state	19. protocol	28. model denotation	37. physical token
10. social system			

APPENDIX 2: FUNDAMENTAL CONCEPTS IDENTIFIED BY THE FRISCO REPORT

The following list of concepts is extracted from the "Summary of Assumptions and Definitions" [Falkenberg et al, 1998, pp. 83-91] at the end of the FRISCO report's Chapter 3, "Information System Concepts: An Integrated Overview." The table shows that each definition number includes one or several concepts. The definitions with higher definition numbers typically use terms from definitions with lower definition numbers. For example:

(Definition 1) A **thing** is any part of a conception of a domain (being itself a "part" or "aspect" of the "world"). The set of all things under consideration is the conception of that domain.

(Definition 2) A **predicator** is a thing, used to characterise or qualify other things, and assumed as being "atomic", "undividable" or "elementary".

(Definition 38) **Shared knowledge** is that knowledge of the individuals in a group of human actors, which they assume to be identical (or at least similar) to that of the others, as resulting from the negotiation process implicit in some communication.

Definition #	Concept, related concepts, and synonyms
1	Thing
2	Predicator, predicated thing
3	Relationship
4	Set membership, elementary thing, composite thing
5	Entity
6	Type, population, instance,
7	Transition, state, pre-state, post-state
8	State-transition structure
9	Composite transition
10	Transition occurrence
11	Relative time, absolute time
12	Rule
13	Actor
14	Action, composite action, action occurrence, co-action
15	Actand, input actand, output actand, resource
16	Action context
17	Goal, goal-pursuing actor
18	Domain, domain component, domain environment
19	Human actor, perception, perceiving action, perceiver
20	Conception, conceiving action, conceiver, conceiving context
21	Interpreting action, interpreter, interpreting context
22	Symbol, alphabet, construct, language
23	Representative, representing action, representer, representing context
24	Label, reference
25	Semiotic level
26	Model, model denotation
27	Modelling action, modeller
28	Intentional model, extensional model
29	Meta-model
30	System, system denotation, system component, system environment, system viewer, system representer
31	Dynamic system, static system, active system, passive system, open system, closed system
32	Sub-system

33	Knowledge
34	Data
35	Message, message transfer, sender, receiver
36	Information
37	Communication
38	Shared knowledge
39	Organizational system, norm
40	Information system, information system denotation
41	Computerized information sub-system

APPENDIX 3: PROPOSED FUNDAMENTAL CONCEPTS FOR WORK SYSTEMS AND A HYPOTHETICAL CASE DEMONSTRATING THEIR BROAD APPLICABILITY

The first column in the tables in this Appendix lists the second layer FCs related to "work system" and eight elements of the work system framework (Figure 1). Each FC is classified as a component, function, characteristic, or performance variable. Most fit cleanly within these categories but some do not fit very well. Since the first layer comprises 10 FCs, the second layer FCs are numbered sequentially from 11 to 106.

The second column contains a related sentence extracted from a hypothetical case about a fictional company called Fruitless Pies, Inc. (FPI), whose executives are discussing a new product idea involving customized pies fashioned to regional events and tastes. Ideally, these hypothetical excerpts should demonstrate that each of the FCs is pertinent to the work system in the hypothetical case and is probably pertinent to understanding most other work systems.

In this case, the elements of the work system can be summarized as follows:

- The *work system* extends from determining customer requirements through acceptance of shipments.

- The *business process* includes steps for defining the customer requirement, committing to deliver, manufacturing the pies, packaging them, and delivering them.
- The *products and services* center around the customization and delivery of pies. The *customers* are distributors and restaurants.
- The *participants* include people in sales, manufacturing, and delivery.
- The *information* includes product options, current and past orders, inventories, staffing, and customer payment histories.
- The *technology* includes ovens, manufacturing software, sales software, laptop computers, a national intranet, and local servers.
- The *infrastructure* includes the corporate mainframe and the Internet.
- The *context* includes increased competition, an unfavorable report from OSHA about work conditions in the factory, and a recent fad of complaining about nutrition-free foods.

Table A3-1. Second Layer FCs Related to WORK SYSTEMS

Fundamental concept (second layer)	**Related sentence in a hypothetical case**
Components	
(11) Goals	Our sales and manufacturing systems should allow us to maintain our current profit rates while shipping 25% of our production as customized pies in quantities as small as 10.
(12) Constraints	We can't rebuild the factory or even convert to computerized ovens due to the dollar expenditures and lost production.
Functions	
(13) Management of the work system	The sales VP and operations VP manage everything from order entry to delivery with the help of three district directors and two manufacturing directors.
Characteristics	
(14) Degree of disagreement about goals	The sales people are adamant about being able to ship customized pies within 48 hours of receiving the order, but the manufacturing directors seem adamant about going for a 72-hour turnaround with higher quality.
(15) Mutual alignment between work system components	Neither our current manufacturing process nor our current information defining specific customer orders would support the production of customized products.
Performance variables	
(16) Measures of performance	The primarily measures of the entire system are the percentage of orders shipped within 48 hours and the internal cost per pie.

Table A3-2. Second Layer FCs Related to CUSTOMERS

Components	
(17) Internal customers vs. external customers	Distributors and restaurants are the primary customers, but we also have to provide data for our compliance officer who produces quarterly or annual reports for government agencies such as OSHA, the FTC, and the EPA.
(18) Stakeholders	The product development staff has developed customization methods for two years and might even quit if the customization methods are not adopted.
Functions	
(19) Customer experience	In addition to dealing directly with our sales people, customers can review product options on our Web site, can enter orders, and can expect delivery direct to their warehouses or stores.
Characteristics	
(20) Degree of divergence in needs of different customers	The distributors and restaurants have different needs related to packaging, turnaround time, types of customization, and billing details.
Performance variables	
(21) Customer satisfaction	Maintaining customer satisfaction requires setting expectations for quality and price and delivering reliably relative to those expectations.

Table A3-3. Second Layer FCs Related to PRODUCTS AND SERVICES

Components	
(22) Products vs. services	The product is pies, but services related to delivery and customization are increasingly important.
(23) Physical products vs. information products	The pies are a physical product but we could provide better information such as customized nutritional analysis of the customized pies
(24) By-products	With a manufacturing yield of around 95%, around 5% of the pies we bake must be sold as substandard or carted away as waste.
Functions	
Characteristics	
(25) Commodity vs. customized	Around 99% of current production is the 12 standard pies that we sell, but we want to increase the customized pies to around 25%.
(26) Substitute products	Our competitors produce comparable products and the restaurants and distributors can easily move to alternatives for our standard products.
Performance variables	
(27) Cost to the customer	The selling price per pie is competitive, but our some of our larger customers say that interacting with us takes too much of their time and effort.

(28) Quality	Our pies are viewed as high quality in terms of taste and appearance, but we receive complaints about their poor nutritional value.
(29) Responsiveness	Our customers are quite satisfied with our ability and willingness to respond quickly to special requests that do not involve customization.
(30) Reliability	Our products are viewed as quite reliable in terms of appearance and taste.
(31) Conformance with standards and regulations	The FDA may soon ban one of the ingredients we and our competitors use to maintain the appearance of freshness.

Table A3-4. Second Layer FCs Related to Business Process

Components	
(32) Process steps	The process steps include defining the customer requirement, committing to deliver, manufacturing the pies, packaging them, and delivering them
(33) Workarounds	The manufacturing process has a defined recipe for each type of pie, but the bakers view the recipes as guidelines and use a number of common workarounds whenever the ingredients are not right or when one type of pie must be cooked in an oven designed for a different type.
Functions	
(34) Decision making	We use simple, straightforward methods for deciding how to juggle production priorities and customer allocations of the work-in-process and finished goods inventory.
(35) Communicating	Communication between the sales force and the factory often takes too long because it goes through hierarchical channels.
(36) Manipulating physical objects	We mix ingredients, form them into pies, bake the pies, package them, and deliver them.
(37) Thinking	We don't spend much time on intellectual work since our business involves a low tech product and reasonably repetitive processes
(38) Processing information	Our methods for capturing order information, transmitting it to the order database, and analyzing minute-to-minute operational options are not effective.
Characteristics	
(39) Degree of structure	Although we use recipes, our manufacturing is semi-structured because there are so many workarounds for variations in ingredients and equipment.
(40) Range of involvement	Each process step tends to be highly localized with little input from other areas related to short-term priorities.
(41) Level of integration	Although information from one step is often used in another step, the groups doing each step operate mostly as individual silos, with comparatively little mutual response to conditions elsewhere.
(42) Complexity	Our sales and manufacturing processes are simple now but will have to become more complex as the percentage of customized product increases.
(43) Rhythm	Our manufacturing operates on steady rhythm of six cycles per shift, two shifts per day.

(44) Degree of reliance on machines	Although we rely on computers for tracking orders, inventories, and deliveries, our manufacturing operations are not computerized and all of the manufacturing equipment is controlled manually.
(45) Prominence of planning and control	We determine a daily schedule each morning but make relatively little use of past manufacturing data to determine whether the schedule is optimal in any sense.
(46) Formality of error and exception handling	We do our best to fix any errors or exceptions that occur, but do not categorize or record the errors and exceptions.
Performance variables	
(47) Activity rate	Our sales people average 5.2 sales calls per day.
(48) Output rate	We produce and ship between 25,000 and 35,000 pies per day, depending on day of the week and proximity of major holidays.
(49) Productivity	Our sales average $500,000 per sales person and our manufacturing averages 125 pies per person hour.
(50) Consistency	Our yield of pies that meet quality standards is around 95% and about half of the remainder is good enough to sell through secondary channels.
(51) Cycle time	It takes 72 hours between scheduling and shipping for a new one-time order although 60% of our production is scheduled a week or two in advance based on long-standing relationships.
(52) Downtime	The ovens have scheduled downtime of 2% and unscheduled downtime of around 0.5%.
(53) Security	We have had no known incidents of sabotage or external interference.

Table A3-5. Second Layer FCs Related to PARTICIPANTS

Components	
(54) Jobs roles	Important job roles include sales person, production supervisor, baker, packaging technician, and delivery driver.
Functions	
Characteristics	
(55) Mastery of necessary skills	The sales force is adequate for commodity selling but may not have the skills needed for selling customized pies effectively.
(56) Congruence between incentives and goals of the work system	The volume-oriented incentives for both Manufacturing and Sales will discourage them from dealing with customized product.
(57) Fit between personal characteristics and work system	About half the people in the manufacturing plant are bored out of their wits by the repetitiveness of the work and what they see as a lack of personal expression.
Performance variables	
(58) Individual productivity	Our best sales people sell twice as much as our weakest sales people in comparable territories.
(59) Quality of individual output	Some sales people develop strong customer loyalty to FPI, but others do little more than take orders.
(60) Attentiveness	Our bakers take their work seriously and are attentive enough to produce highly customized pies.
(61) Job satisfaction	The current sales process requires too much traveling by the sales force and some good sales people are ready to leave due to burn-out.

Table A3-6. Second Layer FCs Related to INFORMATION

Components	
(62) Database and file	Our database lacks direct links between the customer file and the work-in-process file.
(63) Data item	Our computerized information is ineffective for short term planning because it does not include short term forecasts.
(64) Document	The sales people need some way of presenting information about recipes and how they can be customized.
(65) Message	Transmission of requests and commitments between the sales people and manufacturing staff is awkward and error prone.
Functions	
Characteristics	
(66) Data vs. information vs. knowledge	Two lead bakers have a great deal of knowledge that might be lost if either of them leaves and moves to the competition.
(67) Hard vs. soft information	We do not do enough with soft information such as the attitudes and wishes of our largest customers.
(68) Source of information	Since we are concerned with an order cycle and manufacturing and delivery, there is no mystery about the source of most information.
(69) Age of information	Our operational information is current, the order data is up to one day old when manufacturing receives it, and some of our information about customers hasn't been updated in several years.
(70) Level of summarization	We do very little summarization of information and tend to focus on the details of individual orders.
(71) Format	The format of our manufacturing reports does not help in understanding our responsiveness to customer requests.
Performance variables	
(72) Accuracy	The information about orders is 99% accurate, but the sales prospecting information is full of errors.
(73) Precision	The recipes for pies are only guidelines since the cooking time depends on variability from one batch of ingredients to the next.
(74) Timeliness	The nightly downloads of new orders are not timely enough to support the planning needed for customized manufacturing.
(75) Completeness	Our computerized information about orders and manufacturing is complete for the current process, but we will need additional data fields related to customization options.
(76) Accessibility	When we have manufacturing problems the lack of customer information in the work-in-process data makes it more difficult to get back to customers to ask them about their priorities.
(77) Degree protection from unauthorized access	Last month we caught one of our bakers leaving the plant with a complete set of recipes for every pie we sell.

Table A3-7. Second Layer FCs Related to TECHNOLOGY

Components	
(78) Computer and network hardware	The headquarters computers, the network, and the sales force laptops are all current and support near term needs, but the transmission of order data to the factory occurs only nightly.
(79) Data capture devices	We might make better use of bar coding to support tracking and data collection within the factory.
(80) Storage devices	Our hard disk storage is adequate and can be expanded easily.

(81) Display devices	Existing monitors and laptop screens are fine for our purposes, although the display panels for the ovens do not provide clear information about the state of the production run.
(82) Computer and network software	Our manufacturing software was purchased from a vendor about 8 years ago and has not been updated.
(83) Non-computer technology	Our mixers and ovens are not state of the art but are reliable and will not be upgraded in the near future.
Functions	
(84) User interface	People can obtain information about their own silos easily enough, but the methods for combining data from different operational areas are difficult and ineffective.
Characteristics	
(85) Conformance with standards	Our computer hardware and network are as vanilla as we can make them but our manufacturing software does not conform to current programming practice.
(86) Operating conditions	The only place where this is an issue is that our ovens tend to operate less reliably when the humidity is high.
(87) Portability	It would be nice if the sales force's laptops were lighter and had longer lasting batteries.
(88) Interoperability	Our hardware upgrades over the last five years make this an non-issue for hardware, but on the software side several information systems contain inconsistent data definitions.
(89) Modularity	The manufacturing software contains a number of large programs that are not particularly modular.
(90) Scalability	Our computer hardware is scalable but our manufacturing facility could not support more than three times the current volume.
Performance variables	
(91) Ease of use	Our main ease of use issue involves ease of combining data from different parts of the organization.
(92) Capacity	Our computers and network have enough capacity to support double the current transaction volume.
(93) Speed	Data access through the network is the only place where speed has been an issue, and it is adequate for now.
(94) Price-performance	Our hardware is comparatively expensive on a rated capacity basis, but we are generally satisfied with its overall performance.
(95) Reliability	Our various computers and networks go down occasionally, but this is an annoyance rather than major problem.
(96) Maintainability	Our computer and network technology is easily maintainable but the software is becoming harder to maintain due to sloppy upgrades four years ago.

Table A3-8. Second Layer FCs Related to INFRASTRUCTURE

Components	
(97) Technical infrastructure	Our company's computer infrastructure is adequate, but we are concerned about energy supplies and may have to buy a generator.
(98) Information infrastructure	Our information systems were built to support functional areas and do not serve well as an information infrastructure.
(99) Human infrastructure	Our support staff in all areas of the company is extremely thin because we like to run lean.
Functions	
Characteristics	

Performance variables

Table A3-9. Second Layer FCs Related to CONTEXT

Components	
(100) Organizational culture	Our general culture is laid back and sometimes seems lackadaisical even though most people are serious about doing their work well.
(101) Organizational policies and procedures	Our policy of rewarding people based on seniority often conflicts with our need to respond to changing market demands.
(102) Organizational politics	Organizational politics is pretty minimal here and we have a long history of working together effectively.
(103) Stakeholder interests	A number of talk show hosts and other thought leaders have started a campaign of making fun of nutrition-free foods.
(104) Organizational history	This company has been in business for 40 years and has a long history of monitoring customer's needs and gradually adjusting to trends and changes in taste.
(105) Legal and regulatory requirements	We generally conform to OSHA, FDA, and EPA rules, but did have an unfavorable report from OSHA last year about working conditions in the factory.
(106) Competitive situation	We need to respond to new products from competitors that are attracting a lot of interest.
Functions	
Characteristics	
Performance variables	

APPENDIX 4: PROPOSED FUNDAMENTAL CONCEPTS FOR WORK SYSTEMS, INFORMATION SYSTEMS, WORK SYSTEM PROJECTS, AND INFORMATION SYSTEM PROJECTS

This appendix starts with the 106 fundamental concepts in Appendix 3 related to work systems in general. It adds the other fundamental concepts cited in the article. Those additional fundamental concepts are related to information systems, work system projects, and information system projects. This Appendix is designed to highlight the level at which each fundamental concept occurs.

The two layers of work system concepts are shown in the first column, with the first layer concepts capitalized and the second layer concepts indented. The additional concepts related to information systems, work system projects, and information system projects are shown in the second column following the first layer concept with which they are most closely associated.

Fundamental concepts for work systems, FIRST LAYER FC's CAPITALIZED >>> related second layer concepts are indented	Additional fundamental concepts for *IS>>>: information systems, WS proj>>>: work system projects, IS proj>>>: information system projects*
(1) SYSTEM	
(2) WORK SYSTEM	
>>> (11) Goals	
>>> (12) Constraints	
>>> (13) Management of the work system	
>>> (14) Degree of disagreement about goals	
>>> (15) Mutual alignment between work system components	
>>> (16) Measures of performance	
	IS>>>: (113) information system
	IS>>>: (114) difference between an information system and the work system(s) it supports or automates
	WS proj>>>: (126) anticipated benefits
	IS proj>>>: (139) user involvement

(3) CUSTOMERS	
>>> (17) Internal customers vs. external customers	
>>> (18) Stakeholders	
>>> (19) Customer experience	
>>> (20) Degree of divergence in needs of different customers	
>>> (21) Customer satisfaction	
	WS proj>>>: (128) sponsor

(4) PRODUCTS and SERVICES	
>>> (22) Products vs. services	
>>> (23) Physical products vs. information products	
>>> (24) By-products	
>>> (25) Commodity vs. customized	
>>> (26) Substitute products	
>>> (27) Cost to the customer	
>>> (28) Quality	
>>> (29) Responsiveness	
>>> (30) Reliability	
>>> (31) Conformance with standards and regulations	
	WS proj>>>: (124) project plan
	WS proj>>>: (125) project budget
	WS proj>>>: (127) project justification
	WS proj>>>: (129) project deliverables
	IS proj>>>: (140) documentation

(5) BUSINESS PROCESS	
>>> (32) Process steps	
>>> (33) Workarounds	
>>> (34) Decision making	
>>> (35) Communicating	
>>> (36) Manipulating physical objects	
>>> (37) Thinking	
>>> (38) Processing information	
>>> (39) Degree of structure	
>>> (40) Range of involvement	
>>> (41) Level of integration	
>>> (42) Complexity	
>>> (43) Rhythm	
>>> (44) Degree of reliance on machines	
>>> (45) Prominence of planning and control	
>>> (46) Formality of error and exception handling	
>>> (47) Activity rate	
>>> (48) Output rate	
>>> (49) Productivity	
>>> (50) Consistency	
>>> (51) Cycle time	
>>> (52) Downtime	
>>> (53) Security	
	IS>>>: (107) capturing information
	IS>>>: (108) transmitting information
	IS>>>: (109) storing information
	IS>>>: (110) retrieving information
	IS>>>: (111) manipulating information
	IS>>>: (112) displaying information
	IS>>>: (117) voluntary vs. mandatory usage
	WS proj>>>: (120) initiation
	WS proj>>>: (121) development
	WS proj>>>: (122) implementation
	WS proj>>>: (123) operation and maintenance
	WS proj>>>: (130) critical path
	WS proj>>>: (131) project planning
	WS proj>>>: (132) analysis
	WS proj>>>: (133) design
	WS proj>>>: (134) debugging
	WS proj>>>: (135) conversion/cutover
	IS proj>>>: (139) internal design vs. external design
	IS proj>>>: (142) programming
	IS proj>>>: (143) unit testing vs. system testing
	IS proj>>>: (144) software change control

	IS proj>>>: (145) acceptance testing

(6) PARTICIPANTS	
>>> (54) Jobs roles	
>>> (55) Mastery of necessary skills	
>>> (56) Congruence between incentives and goals of the work system	
>>> (57) Fit between personal characteristics and work system	
>>> (58) Individual productivity	
>>> (59) Quality of individual output	
>>> (60) Attentiveness	
>>> (61) Job satisfaction	
	IS>>>: (115) user
	WS proj>>>: (136) outsourcing
	IS proj>>>: (146) programmers
	IS proj>>>: (147) analysts
	IS proj>>>: (148) technical writers
	IS proj>>>: (149) trainers

(7) INFORMATION	
>>> (62) Database and file	
>>> (63) Data item	
>>> (64) Document	
>>> (65) Message	
>>> (66) Data vs. information vs. knowledge	
>>> (67) Hard vs. soft information	
>>> (68) Source of information	
>>> (69) Age of information	
>>> (70) Level of summarization	
>>> (71) Format	
>>> (72) Accuracy	
>>> (73) Precision	
>>> (74) Timeliness	
>>> (75) Completeness	
>>> (76) Accessibility	
>>> (77) Degree protection from unauthorized access	
	WS proj>>>: (137) requirements
	IS proj>>>: (150) test data

(8) TECHNOLOGY	
>>> (78) Computer and network hardware	
>>> (79) Data capture devices	
>>> (80) Storage devices	
>>> (81) Display devices	
>>> (82) Computer and network software	

>>> (83) Non-computer technology	
>>> (84) User interface	
>>> (85) Conformance with standards	
>>> (86) Operating conditions	
>>> (87) Portability	
>>> (88) Interoperability	
>>> (89) Modularity	
>>> (90) Scalability	
>>> (91) Ease of use	
>>> (92) Capacity	
>>> (93) Speed	
>>> (94) Price-performance	
>>> (95) Reliability	
>>> (96) Maintainability	
	IS>>>: (116) user interface
	IS proj>>>: (151) programming languages
	IS proj>>>: (152) database management systems
	IS proj>>>: (153) programming tools

(9) INFRASTRUCTURE	
>>> (97) Technical infrastructure	
>>> (98) Information infrastructure	
>>> (99) Human infrastructure	
	IS>>>: (118) user support
	IS>>>: (119) technical support

(10) CONTEXT	
>>> (100) Organizational culture	
>>> (101) Organizational policies and procedures	
>>> (102) Organizational politics	
>>> (103) Stakeholder interests	
>>> (104) Organizational history	
>>> (105) Legal and regulatory requirements	
>>> (106) Competitive situation	
	WS proj>>>: (138) inertia

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Communications of the Association for Information Systems

ISSN: 1529-3181