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Communications of the Association for Information Systems

ARCHITECTURE OF SYSPERANTO: A MODEL-BASED ONTOLOGY OF THE IS FIELD

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ABSTRACT

The challenge of defining the domain and core concepts of the IS field is a perennial topic at major IS conferences. This paper describes the architecture of Sysperanto, a model-based ontology of the IS field. Sysperanto is being developed as part of an ongoing effort to create methods that typical business professionals can use to analyze systems and system-related projects for themselves at whatever level of depth is appropriate. The name Sysperanto is meant as a metaphor combining generality (covering the IS field), vocabulary (identification of terms), and structure (internally consistent organization) to create an ontology more powerful and useful than a list of keywords or propositions. Sysperanto's architecture provides an organizing framework for codifying the disparate and inconsistent propositions, methods, and findings that constitute the current state of IS knowledge and, in combination, form a major obstacle to knowledge accumulation and use in the IS field.

Instead of yet another discussion of whether the IS field lacks a conceptual core and what might be the consequences of such a shortcoming, this paper proposes an architecture and preliminary details of a plausible set of core concepts for the IS field. It starts by summarizing Sysperanto's goals and explaining why work system concepts, rather than information system concepts, are the core of Sysperanto. It presents Sysperanto as a terminological ontology and explains the underlying meta-model. The meta-model is designed to support tools for analyzing systems from a business viewpoint and to help in codifying and organizing knowledge in the IS field. It uses a conceptual map based on extensiveness and guidance in application to compare Sysperanto with other efforts to organize ideas in the IS field.

It may be several years before a complete version of Sysperanto is tested through its use in a formal method for analyzing systems or through comparison with other attempts to codify knowledge in the IS field. Nonetheless, its architecture is well enough defined to be compared to the architecture (or lack of architecture) in previous and future approaches for understanding and organizing the basic concepts about information systems.

Keywords: ontology of information systems, information systems concepts, systems analysis, architecture, work systems, Sysperanto

I. INTRODUCTION

This paper explains the architecture of Sysperanto, a model-based ontology of the IS field. Sysperanto is a direct response to the challenge of defining the domain and core concepts of the IS field. When fully implemented, Sysperanto will be a highly organized, internally consistent mapping of most of the fundamental concepts in the IS field. This mapping will be useful for organizing and codifying knowledge in the field and as the conceptual basis of systems analysis methods that business and IT professionals can use to attain mutual understanding of existing systems, proposed improvements, and new systems. Sysperanto may not be the only ontology addressing these goals. However, although the IS field abounds with frameworks, technical vocabulary lists, and discussions of disparate topics, none of the published efforts thus far integrates a large number of the IS field's basic concepts and empirical findings in a form that enhances their usefulness for business and IT professionals.

The challenge of defining the domain and core concepts of the IS field is a perennial topic in IS journals and at major IS conferences. At the first ICIS conference Dickson et al [1980] used the term "identity crisis" and said, "Since the early days of activity in our area, academics and practitioners alike have argued about what constitutes the area and where are its priorities. …. We have still not settled on what should be included or excluded from our area." Subsequently, four ISCO (Information Systems Concepts) conferences sponsored by IFIP 8.1 in 1989, 1992, 1995, and 1999 attempted to identify the basic concepts of IS, but ultimately produced reports [Falkenberg et al, 1995; Falkenberg et al, 1998; Verrijn-Stuart, 2001] that were less than satisfying to many of the main participants in the effort. The call for contributions to the 1998 IFIP 8.2 and 8.6 conference immediately preceding the Helsinki ICIS noted that "practical as well as theoretical conceptual frameworks aimed at integrating diverse aspects of IS/IT change effects are rare. The field is very fragmented. Therefore, the advancement of integrated practical views and theories of a holistic nature are needed." It asked, "how can we make theory practical and practice generalizable?" [Larsen et al, 1998]. More recently, major panels in the ICIS 2002 and 2003 conferences focused on the presence of the IT artifact in IS research [Boland, 2002] and the importance of a core theory of IS [Karahanna, 2002; 2003]. The difficulty of defining the core concepts of the IS field also contributed to recent controversies in a number of business schools about whether it is necessary or even important to include an IS course within the MBA core [Ives et al, 2002]. Continuing the discussion begun 23 years earlier, in 2003 an *MIS Quarterly* article appeared with the title "The Identity Crisis within the IS Discipline: Defining and Communicating the Discipline's Core Properties." [Benbasat and Zmud, 2003] Within 9 months, 11 related articles appeared in *CAIS* and 4 appeared in *JAIS*.

HISTORY OF SYSPERANTO

The effort to develop Sysperanto grew out of a long term, applied research project (starting around 1992) attempting to develop a set of systems analysis techniques that business professionals can use at whatever level of depth is appropriate for:

- creating an initial understanding by summarizing a system in business terms before an IT expert interprets and explains it as an IT system
- understanding enough about a system to provide meaningful input to someone else's analysis
- exploring a situation in enough depth to produce a tentative analysis before talking to others who will fill in missing details and technical knowledge
- understanding enough about a situation to ask the right questions about someone else's analysis or proposal.

At each stage in the research, the adequacy of the current iteration of the approach was evaluated based on successes and shortcomings of group and individual reports written by employed MBA and EMBA students about systems in their own organizations.[1] After several iterations it became clear that these reports for an introductory IS course needed to analyze the work system that was being supported by the information system in order to provide meaningful recommendations. This conclusion is consistent with statements by many theorists (e.g. Ackoff [1993], Checkland [1997]) that the analysis of a system in an organization requires an understanding of the system being served. A revised version of the approach made the IT-reliant work system the basic unit of analysis (i.e., not just the usage or context of an information system). [Alter, 1999; 2003a]. Work system concepts solidified gradually without changing the basic goal of providing business professionals a well organized, reasonably rigorous method for analyzing systems at whatever level of depth is appropriate. Eventually, this approach was named “the work system method” [Alter, 2002], in effect a design theory for helping business professionals attain a good understanding of a work system, how well it performs, and how it might be improved.

A review of the first eight years of progress in developing the work system method generated four observations that motivated the attempt to develop Sysperanto:

- Business professionals have a common sense understanding of everyday language, but typically lack an organized vocabulary for understanding systems in organizations.
- Knowledge about systems in organizations should play an integral role in systems analysis methods. Current systems analysis textbooks tend to emphasize methods for documenting the codified information, business process steps, and technology in computerized systems, but incorporate little or no available knowledge about the non-computerized aspects of systems in organizations.
- It is difficult to organize or codify knowledge about information systems because different researchers use different meanings for basic terms such as system, user, stakeholder, implementation, and requirements. [Alter, 2000]
- Initial efforts toward developing the work system method showed that many fundamental concepts related to information systems apply to almost any work system. [Alter, 2001]

Accordingly, the development of Sysperanto is progressing based on the belief that the core of the IS domain is concepts related to IT-reliant work systems [Alter, 2003a] rather than other plausible starting points such as information systems *per se*, IT artifacts, general systems theory, or information theory.

The name Sysperanto serves as a guiding metaphor rather than an operational goal. It is a play on Esperanto[2], a consciously developed “universal” language that almost no one speaks.[3]

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[1] Using students to represent users, systems analysts, or business decision makers is relatively common in the IS literature because it is so difficult and expensive for researchers to obtain first hand observations about IS phenomena across multiple real world cases. For example, Sabherwal and Robey [1993] explain how they used reports from 53 student groups over two years to develop a taxonomy of implementation processes. The validity of using students in research depends on the nature of the issues being studied and the type of research information that is collected. The research discussed here used over 250 reports produced between 1997 and 2004 by MBA and EMBA students, early-career business professionals with varying degrees of experience, most of whom were employed when they wrote the reports. People with this profile often serve as user representatives in IS development and implementation projects. The research was about how well the reports applied successive versions of a systems analysis method to make sense of real world situations that at least one team member was familiar with. Even though some reports were not useful (as Sabherwal and Robey also observed), it is doubtful that any other practical approach for developing a systems analysis method could have generated the amount of meaningful feedback found in over 250 reports.

[2] Esperanto was developed by L. L. Zamenhof who introduced it in 1887. [http://en.wikipedia.org/wiki/Esperanto]

Sysperanto will include various concepts from general systems theory, sociotechnical theory, organization theory, TQM, and other sources. Ideally, Sysperanto will combine generality (covering the IS field), vocabulary (identification of terms), and structure (internally consistent organization) to create an ontology more powerful and useful than a list of keywords or propositions. Sysperanto will not be a language, but rather, a reasonably clear organizing structure and set of concepts can be used effectively when describing and analyzing systems in organizations. This direct or indirect use could occur via general acquaintance with the ideas or via printed templates, interactive documentation and analysis tools, or expert systems.

Even a partially shared understanding of the ideas in Sysperanto would help managers and other business professionals discuss system-related issues and communicate with IT professionals, many of whom tend to focus on IT-related issues and deemphasize social and organizational issues. Sysperanto would also help in codifying the disparate and inconsistent propositions, methods, and findings that constitute the current state of IS knowledge and stand as a formidable obstacle to theory development in this field. Thus, Sysperanto is being developed to serve both the very practical purpose of helping people understand systems and the more theoretical purpose of codifying IS knowledge for researchers. These two purposes are mutually reinforcing because each presents opportunities, insights, and challenges that are relevant to the other.

CHARACTERISTICS OF SYSPERANTO

The architecture of Sysperanto assumes systems in organizations should be viewed as work systems whether or not IT plays a major role. Work systems can be described using concepts and principles based on two models:

- the work system framework [Alter, 2003a], which identifies nine elements included in even a rudimentary understanding of a work system in operation
- the work system life cycle model [Alter, 2003a], which represents a work system's evolution over time through iterations of four phases, each of which may include unplanned adaptations and improvisation.

Sysperanto treats information systems, projects, supply chains, and even e-commerce web sites as special cases of work systems that should inherit most of the properties of work systems in general. The relevant properties can be classified within categories including components and phenomena, actions and functions, characteristics, and performance indicators, among others. Sysperanto's use of the work system framework to organize concepts and knowledge related to each of the work system elements should make it easier for users of the work system method to access and use existing knowledge and theories.

Given the IS field's continual difficulties with inconsistent terminology and lack of agreement about the core of the field, Sysperanto's architecture is important because:

- it provides a plausible way of organizing the main concepts within this domain and
- it presents a challenge to other approaches for organizing those ideas.

Sysperanto's architecture may or may not be optimal, but no current alternatives attempt to cover the richness of the IS field and attempt to do so in depth. For example, UML is a set of powerful conceptual modeling tools including various structural diagrams, behavior diagrams, and management diagrams. However, it covers only a subset of the technical, social, and organizational issues that should be considered when describing or analyzing systems in organizations. Similarly, soft system methodology provides a useful approach for creating a broad system view of a situation, but it specifies only a small percentage of the many key

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[3] But some apparently do speak it. For example, the late composer Lou Harrison "spoke Esperanto fluently and set several texts in that language." [Ross, 2003]

concepts that are useful in analyzing the situation in more depth. Given the fundamental nature and importance of being able to organize and make sense of the basic concepts in the IS field, it is worthwhile to discuss the architecture now, possibly several years before a reasonably complete version of Sysperanto is produced and tested.

ORGANIZATION OF THIS PAPER

This paper proceeds as follows. A brief section (Section II) summarizes the work system framework and other ideas that form the foundation of Sysperanto. (Appendices 1 and 2 and articles referenced in this article explain these ideas in more detail.) Another brief section (Section III) explains that Sysperanto is a model-based ontology. The core of the paper (Section IV) is an explanation of how Sysperanto's architecture organizes the concepts in the IS field. That explanation includes figures and detailed tables illustrating important features of Sysperanto, such as its use of partial inheritance to organize work system types, work system elements, "slices," and properties. Appendix 3 clarifies the nature of Sysperanto by comparing it to a number of other topics in the IS literature, such as the *MIS Quarterl*y keyword index, the Zachman enterprise architecture framework, upper-level ontologies, soft systems methodology, the Cyc knowledge base, and the proposed semantic Web. Sysperanto addresses some of the issues addressed by these disparate efforts. It attempts, however, to progress in a new way because it starts from work system concepts that can be used by typical business professionals rather than from highly abstract concepts that can be understood mainly by computer scientists, philosophers, and Ph.D. level researchers.

II. WORK SYSTEM CONCEPTS AS THE CORE OF SYSPERANTO

The basis of Sysperanto is the concept of work system, a term used by a number of socio-technical researchers and by some practitioners, but apparently in a less specific sense than it will be used here.[4] For our purposes, a work system is a system in which human participants and/or machines perform work using information, technology, and other resources to produce products and/or services for internal or external customers. Typical business organizations contain work systems that procure materials from suppliers, produce products, deliver products to customers, find customers, create financial reports, hire employees, coordinate work across departments, and perform many other functions. It is possible to view an entire organization, firm, or even an industry in work system terms, but that is not the intention here. For our purposes, organizations are best viewed as consisting of multiple work systems rather than as a single,

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[4] The term *work system* appeared in two articles in the first volume of *MIS Quarterly* [Bostrom and Heinen, 1979a, 1979b]. Mumford and Weir [1979, p. 3] spoke of "the design and implementation of a new work system." Davis and Taylor [1979, p. xv] mentioned "attempts at comprehensive work systems design, including the social systems within which the work systems are embedded." Trist [1981] said that "primary work systems are the systems which carry out the set of activities involved in an identifiable and bounded subsystem of a whole organization - such as a line department or service unit." [p. 11] and "The primary work system ...may include more than one face-to-face group along with others in matrix and network clusters." [p. 35] More recently, Mumford [2000] summarized sociotechnical insights cited by Pasmore [1985], such as "The work system should be seen as a set of activities contributing to an integrated whole and not as a set of individual jobs" and "The work system should be regulated by its members, not by external supervisors." Land [2000] said "socio-technical methods focus on design of work systems to improve the welfare of employees. The prime aim of redesigning work systems is the improvement of the quality of working life." Other IS researchers such as Sumner and Ryan [1994] and Mitchell and Zmud [1999] also used the term. In addition, the term *high performance work system* appeared occasionally in the popular business press and in some consulting circles to describe organizations with high degrees of participation and self-management.

large work system combining many independent or partly dependent work practices and groups of participants.

According to its definition, work system is a general case of systems operating within or across organizations. Special cases of work systems include information systems, projects, value chains, supply chains, e-commerce web sites, and totally automated work systems. These and other special cases should inherit most of the properties of work systems in general. (Inheritance relationships form an integral part of Sysperanto's architecture).

The purpose of most information systems is to support one or more work systems.[5] Although information systems and the work systems they support were often quite separable decades ago when most business computing was still card-based and batch-oriented, today many important information systems overlap significantly with the work systems they serve. For example, in a payroll system or e-commerce web site that sells and downloads software, most or all of the work system is an information system. In work systems related to producing, transforming, or delivering physical things, information systems may play a less dominant role even if they are essential for a work system's effective operation and success. And in extreme cases such as highly automated manufacturing, the information system and work system overlap so much that the manufacturing is largely controlled by the information system. Turn off the information system and this type of manufacturing grinds to a halt.

The work system method is being developed as a broadly applicable set of ideas that use the concept of work system as the focal point for understanding, analyzing, and improving systems in organizations, whether or not IT is involved. The work system method is based on two models. The work system framework (Figure 1) identifies the basic elements for understanding and evaluating a current or proposed work system. These elements are defined in Appendix 2. The work system life cycle model describes how a work system evolves over time through planned change and unplanned adaptations. That model and other aspects of the work system approach are summarized in Alter [2003a]. The work system framework (the view of a current or proposed work system) is the basis of Sysperanto because each phase of the work system life cycle model can be described as a work system using the elements shown in Figure 1.

III. SYSPERANTO AS A MODEL-BASED ONTOLOGY

The idea of developing Sysperanto was motivated by a combination of shortcomings in the initial version of the work system method and on-going difficulty organizing and accessing IS concepts and knowledge.[6] As expressed in Figure 2, development of Sysperanto as a formal ontology should help in the continuing development of the work system method and related tools. Conversely, ongoing usage and testing of the work system method should feed into continuing development of Sysperanto as a codification of useful concepts and knowledge in the IS field.

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[5] Note the difference between the concept of work system and a specific instance of a work system (such as a particular firm's sales system). Sysperanto is based on the fact that information systems, projects, and other types of systems discussed in the IS field are all special cases of work systems. In terms of specific instances, however, a particular information system may support one or more specific work systems, any of which may or may not overlap with the information system. (A similar, but simpler distinction between a general concept and specific instances often causes confusion between entity types and specific entities in discussions of entity-relationship diagrams.)

[6] That difficulty continues, as illustrated by Hirschheim and Klein's [2003] call for the development of a body of knowledge for the IS field.

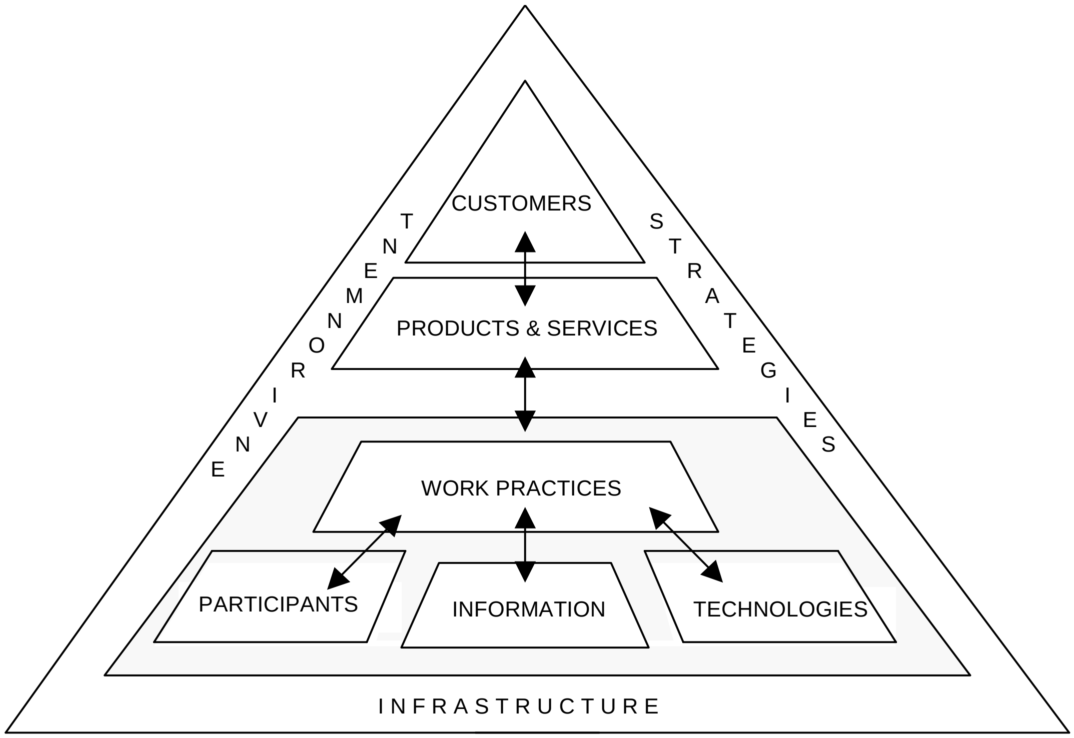


Figure 1. The Work System Framework

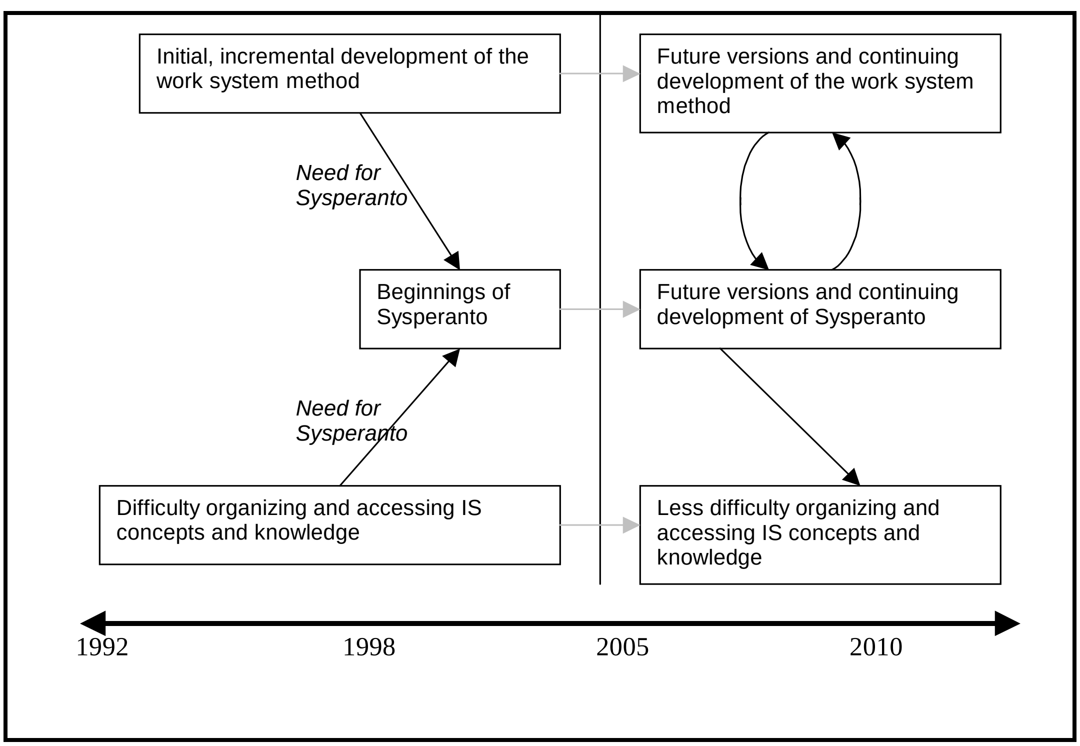


Figure 2. Relationship between Sysperanto and the Work System Method

Sysperanto is being developed as a model-based ontology of the IS field.

> *"Ontology is the way we carve up reality in order to understand and process it."* [Castel, 2002]

> *"An ontology is an explicit specification of an abstract, simplified view of a world we desire to represent. It specifies both the concepts inherent in this view and their interrelationships. A typical reason for constructing an ontology is to give a common language for sharing and reusing knowledge about phenomena in the world of interest."* [Holsapple and Joshi, 2002].

Major uses of ontology include communication between humans and/or computer systems, computational inference, and reuse and organization of knowledge. [Gruninger and Lee, 2002].

Sysperanto fits in the middle of a dimension that Smith and Welty [2001] propose for comparing different types of ontologies based on complexity and extent of automated reasoning. In increasing order of complexity this dimension includes:

- catalogs,
- sets of text files,
- glossaries,
- thesauruses,
- collections of taxonomies,
- collections of frames (that specify relations between objects), and
- sets of logical constraints used for automated reasoning.

Sysperanto fits in the middle because its model-based viewpoint imbues a greater degree of organization than a catalog, glossary, or thesaurus. However, it is not immediately directed at automatic inference (e.g., a DSS is a type of system and systems have purposes, therefore a DSS has a purpose) even though it is sufficiently structured to provide the underpinnings for computerized support of human analysis processes.

Sysperanto combines aspects of what Sowa [2000; 2001a] calls terminological and formal (or axiomatized) ontologies. Although built around a meta-model that provides the possibility of substantial rigor, it encompasses much more than an ontology for defining the information in a computerized database. Human and organizational issues must be included because it views information systems as a special case of work systems in which people perform work using information and technology. Although comparable to some of the domain-specific ontologies that are available through the Web, it is much narrower than the types of ontologies needed for developing automated interfaces between disparate automated systems and for creating the proposed semantic Web [Berners-Lee et al, 2001]. The Cyc knowledge base [Reed and Lenat, 2002] is an extremely broad example that attempts to codify commonsense knowledge about the everyday world. Another example is SUMO, the Suggested Upper Merged Ontology, part of an IEEE effort to create a standard ontology that will support applications for data interoperability, information search and retrieval, automated inferencing, and natural language processing. [IEEE, 2002; Pease et al, 2002]. Two recent *CAIS* articles [Kishore et al, 2004; Sharman et al, 2004] explain much more about computational ontologies.

IV. ARCHITECTURE OF SYSPERANTO

System-related topics can be subdivided into *n* separate sets of ideas in many useful ways. Most if not all of these useful cataloging schemes contain at least some ambiguity about boundaries between some of their categories. The architecture of Sysperanto is one possible way to organize system-related topics. It is expressed in a meta-model based on work systems concepts. This section starts by presenting the two underlying conjectures, adds another conjecture that is less fundamental, and then explains the multi-level structure of the meta-model.

CONJECTURES

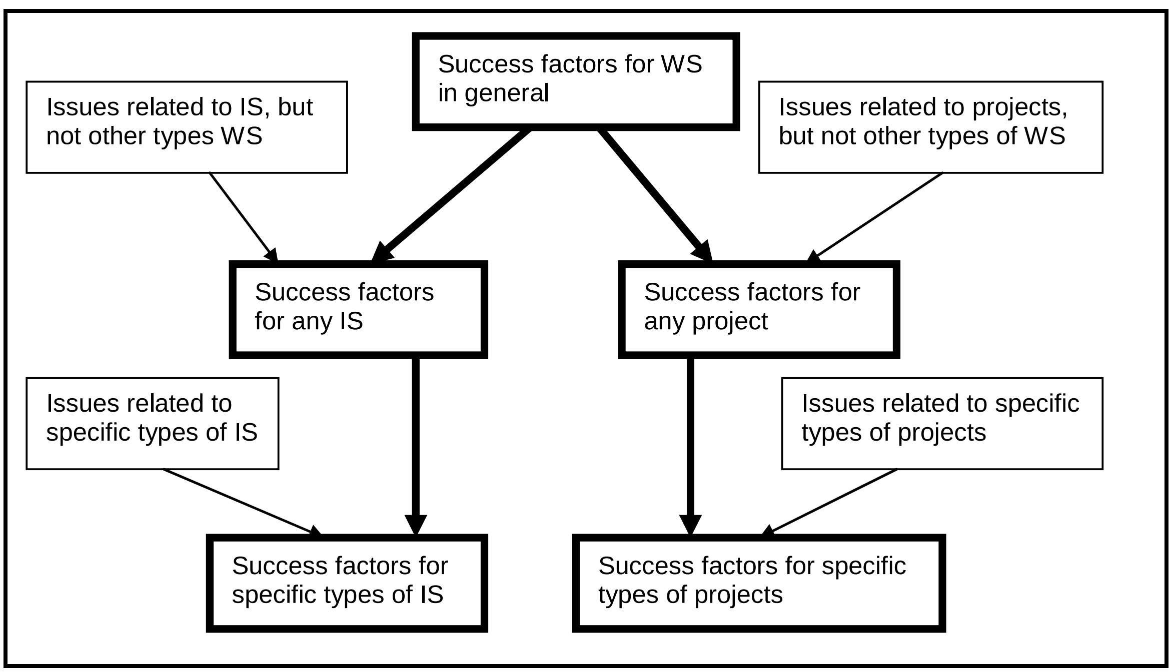
The architecture of Sysperanto is organized around the elements of a work system and the fact that information systems, projects, supply chains, e-commerce, and many other important types of systems can be modeled as work systems. These supertype-subtype relationships provide an opportunity to organize relevant concepts economically through the use of inheritance if two conjectures (partial inheritance and reverse inheritance) are reasonably valid. A third conjecture (level-skipping) may help explain some of the difficulties in codifying knowledge about information systems.

Partial Inheritance Conjecture

> *Most (perhaps 80% or more) of the elements, properties, and propositions for a specific work system type are inherited by more specialized work system types.*

In other words, most, but not necessarily all, of the ideas and vocabulary relevant to work systems are also relevant to information systems, projects, and supply chains. Similarly, most of the ideas relevant to information systems in general are relevant to special cases of information systems such as MIS, CRM, and Knowledge Management Systems. Accordingly, partial inheritance relationships should be useful in organizing knowledge across work system types because most of the knowledge can be associated with the more general work system type and inherited by its subtypes. Note, however, that a more specialized work system type may use a different term for an approximately equivalent element or property.

As a specific example, Figure 3 represents the conjecture that most success factors for work systems are inherited by subtypes (information systems and projects), and that most success factors for those subtypes are inherited by the next level of subtypes (specific types of IS and specific types of projects.) Table 1 illustrates the underlying reality by listing a number of common success factors often related to the success of information systems, projects, or special types of either. Every one of these success factors applies to work systems in general and can be viewed as part of the inheritance from work systems in general to its special cases.



WS=work system

Figure 3. Inheritance of Success Factors by Special Cases of Work Systems

Table 1. Examples of Success Factors Inherited from Work Systems in General by Special Cases of Work Systems such as Information Systems or Projects

Work system element	***Work System Success Factors that are also Pertinent to Special Cases such as information Systems and P-rojects***
Work practices	• Fit of business process with other elements • Adequate resources for work practices • Effective operational management
Participants	• Appropriate skills and understanding • Interest in doing this type of work • Motivation to do this work in this setting • Ability to work together to resolve conflicts
Information	• Adequate information quality • Adequate information accessibility • Adequate information presentation • Adequate information security
Technology	• Ease of use (for IT or other technologies) • Adequate technology performance (“horsepower”) • Maintainability and compatibility
Customers and product/services	• Product design consistent with customer needs • Adequate product performance
Infrastructure	• Adequate technical infrastructure • Adequate human infrastructure
Environment	• Management support • Consistency with culture • Cooperative decisions about work methods • Low level of turmoil and distraction
Strategies	• Fit between work system strategy and organization strategy

Reverse Inheritance Conjecture

> *Most of the elements, properties, and propositions for a specific work system type are also applicable to more general work system types.*

Some of the work system success factors in Table 1 are often cited as success factors for specific types of information systems and projects. Based on this observation and on the partial inheritance conjecture, it is possible that many findings in the IS literature from research about properties of particular work system types are actually applicable to more general work system types. Accordingly, many of the “lessons learned” from empirical research and practitioner experience related to DSS, ERP, or other types of information systems may actually be equally valid for work systems in general. In a specific example, Sherer and Alter [2004] argue that over half of 228 risk factors identified in 46 articles in the IS risk literature are equally plausible as risk factors for work systems in general. Effective organization of IS knowledge should associate each concept and proposition with the most general level at which it is valid.

Level-Skipping Conjecture

> *Most of the properties of information systems in general are inherited from work systems in general; very few additional concepts are related to information systems in general but not work systems in general; most of the additional properties of information systems are related to unique features of specific types of information systems;*

Information systems include transaction processing systems, MIS, CAD systems, e-commerce web sites, expert systems, GDSS, communication systems, and many others. Worth considering, but not fundamental to the structure of Sysperanto, is the conjecture that the various types of information systems differ so greatly in form and function that information systems in general possess few properties in common beyond those inherited from work systems in general. This conjecture might help explain why it is so difficult to generalize about information systems and why the IS field seems to lack a conceptual core. It may turn out that almost all of the useful properties and generalizations about information systems are either about work systems in general or about the various special cases of information systems. To test this conjecture, try to identify any valuable generalizations that apply to all of the information system types mentioned above but do not apply to work systems in general.

META-MODEL

The Concept of "Slice"

Sysperanto is a terminological ontology because it contains categories that "need not be fully specified by axioms and definitions."[7] Sysperanto is designed around a meta-model motivated by the partial inheritance and the reverse inheritance conjectures above and by the recognition that people understand business and organizational reality by slicing it in a variety of ways. In Sysperanto a "slice" (similar to a viewpoint or perspective) is a related set of properties that can be applied when trying to understand or analyze a particular work system. Although slices may overlap, each slice provides a particular set of concepts, associations, and understandings. Many of the frustrations with the current IS discipline reflect its existence as a loose, unsettled conglomeration of partly overlapping ideas associated with conceptual modeling, organization behavior, total quality management, human communication, coordination theory, information theory, computer science, and microeconomics, among many others. Sysperanto is designed to provide a flexible and useful structure that absorbs and organizes many of the valuable ideas from all of these different areas.

Meta-Model in Abstract Form

Figure 4 summarizes the Sysperanto meta-model in an abstract form. The "work system" is the basic unit for understanding any particular system in an organization. Sysperanto organizes concepts and generalizations about work systems. It is organized around work system types, starting with the most general type, "work systems in general." Figure 4 says that any work system type might contain a number of special cases or subtypes. Instances of any work system type are summarized using the work system elements that are relevant to that type. For example, the elements for work systems in general are the nine elements in the work system framework in Figure 1. Each element for any work system type is understood through a series of slices. Each of the slices is described through properties applicable to any specific instance of that work system type. The properties themselves may be components or phenomena, actions or functions, characteristics, performance indicators, relationships, and generalizations, among others. Each part of Figure 4 will now be explained in more depth.

WORK SYSTEMS AND WORK SYSTEM TYPES

Sysperanto is based on the assumption that the basic unit of analysis for understanding systems in organizations is a work system whose participants perform work practices using information, technology, and other resources.

[7] An example of a terminological ontology is WordNet [Miller, 1995], whose categories are partially specified by relations such as subtype-supertype or part-whole, which determine the relative positions of the concepts with respect to one another but do not completely define them. In contrast, a formal (axiomatized) ontology is "a terminological ontology whose categories are distinguished by axioms and definitions stated in logic or in some computer-oriented language that could be automatically translated to logic." [Sowa 2000, 2001a] The meta-model described here only hints at directions in which an axiomatized ontology designed for limited forms of automatic inference might be developed after producing a useful terminological ontology.

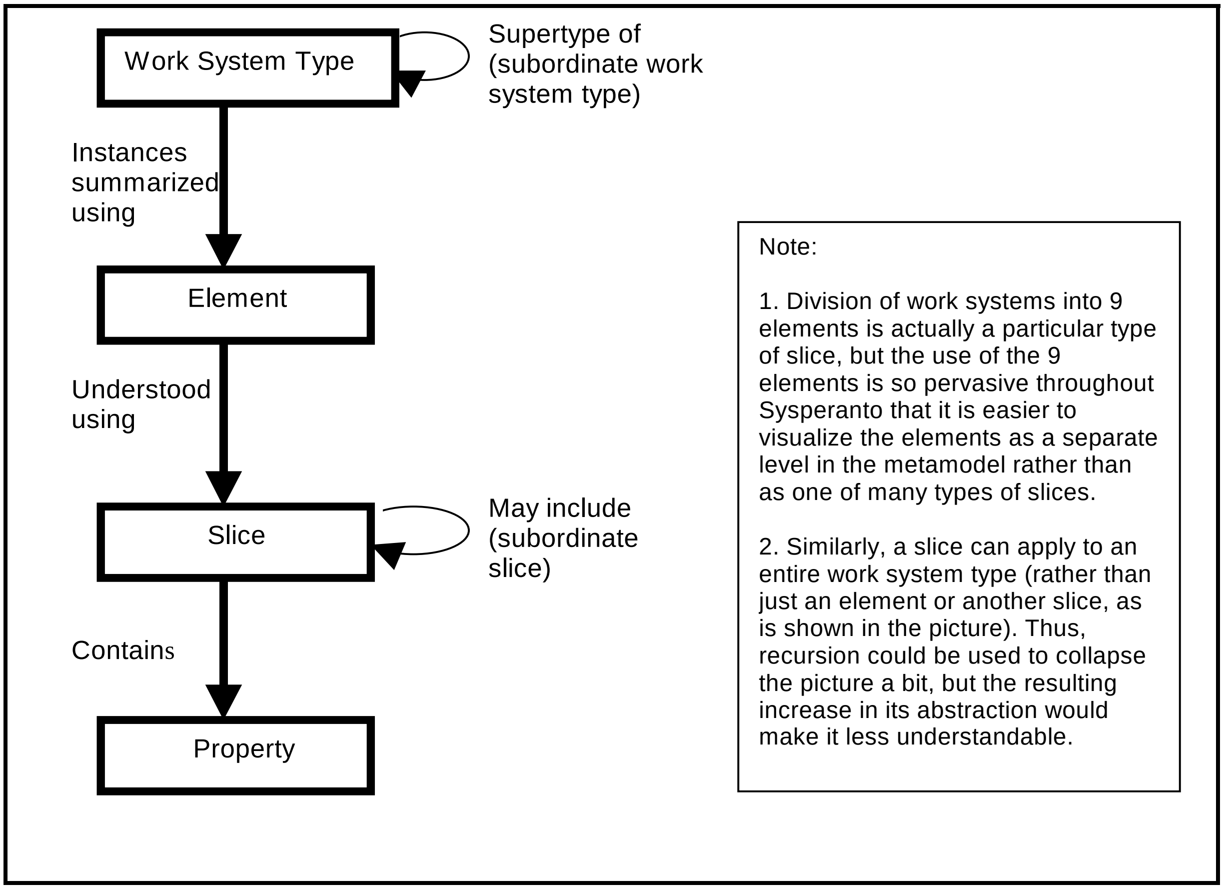


Figure 4: Structure of Sysperanto's Meta-Model

Work System Types

Work system types include work system in general, information system, project, value chain, supply chain, and special cases within each of these, such as expert system (a type of information system) or CRM project (a type of project). As is implied by the different levels in Figure 4, distinctions between work system types are based on:

- inclusion or exclusion of specific elements
- relevance or irrelevance of specific slices
- relevance or irrelevance of specific properties within slices
- specification of particular values or ranges of values for particular properties.

For example, a project is a work system that will cease to exist after it produces certain products. Similarly, an information system is a work system whose work practices involve only processing of information and do not include communication, social relationships, thinking, or physical activity not directly related to processing of information[8]. Supply chains are inter-organizational work systems whose participants include suppliers and their customers, and whose work practices are devoted to establishing and fulfilling customer requirements.

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[8] Computer scientists might prefer a more machine-centered definition of information system, whereas behavioral researchers might prefer a definition closer to work system in general.

Elements of Work Systems

The nine elements in the work system framework (Figure 1) are included in even a rudimentary understanding of the most general case, "work systems in general." The same nine elements apply to closely related subtypes such as information system, project, and supply chain. More distant subtypes of work systems might add or eliminate elements. In addition to the nine elements for looking at different aspects of a work system, "work system as a whole" is treated as a tenth element in the meta-model because some properties of work systems (such as age, geographic dispersion, capacity, and degree of competitive significance) apply to the entire work system rather than to just to one its elements such as the work practices or technology.

Work System Aggregations

Entire departments, organizations, communities of practice, firms, industries, geographic regions, and societies might be viewed as aggregations of work systems and therefore described using work system terms (such as participants, information, technologies, and products and services). These aggregations are beyond Sysperanto's scope even though various characteristics and performance indicators related to various work system elements are used frequently at those aggregate levels. Aggregations are not included because "the work system" becomes increasingly difficult to describe and analyze when it encompasses loosely related groups of participants performing independent or partly dependent activities producing different products and services for different internal and external customers. In addition, some basic ideas about work systems such as the need for alignment between the elements of a work system, either do not apply or are not as meaningful in work system aggregations.

SLICES

In Sysperanto a slice is a related set of properties that can be applied when trying to understand or analyze a particular work system. For convenience, all of the properties of a work system element (or of the entire work system) are grouped within specific slices. The next section explains properties. In most real world situations, many different slices are relevant, and some of those slices may overlap by invoking similar or related concepts. Slices demand further explanation because they might be confused with taxonomies or partonomies[9] ([Guarino and Welty, 2002]; [Gerson, 2000]; [Rogers and Rector, 2000]) that are often associated with ontologies.

Disciplines, subdisciplines, and areas of knowledge can be viewed as particular ways to slice reality in order to understand it. For example, the socio-technical systems approach tends to divide organizational situations in two realms, the social and the technical, each of which can be understood separately using the separate concepts and analysis methods related to these realms. Separating the social from the technical is useful in many ways, but the division itself is artificial and frequently unclear at the boundary. Although issues about personal rivalries are definitely in the social realm and issues about how an algorithm operates on a computer are definitely in the technical, many other issues straddle both. For example, the details of how work is coordinated and executed combine social and technical issues that are difficult to separate.

In the general spirit of slices, Sysperanto subdivides the understanding of any work system into topics related to nine elements plus additional topics related to the entire work system as a whole. Subdividing concepts this way is more fine-grained than dividing the world into two parts (such as

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[9] "Hierarchies of parts are called partonomies" just as taxonomies organize relationships between kinds. Whereas "taxonomies typically are restricted to non-overlapping groups within groups," different partonomies for a particular entity may overlap. For example, in a book, sub-plots and characters cut across different scenes. Similarly, recipes used in cooking "routinely use two different partonomies: a list of ingredients and a set of preparatory steps. The two partonomies are complementary." [Gerson, 2000]

social vs. technical; tactical vs. strategic; customer-focused vs. internally-focused; informate vs. automate; reengineering vs. incremental change). It also includes more categories than:

- the four in Benbasat and Zmud's elements of an IT artifact (information technology, task, task structure, task context) [Benbasat and Zmud, 2003]
- the five in the MIT90s framework (strategy, structure, technology, individuals and roles, management processes) [Scott Morton, 1991] or
- the six that soft system methodology uses (customers, actors, transformations, owners, weltanschauung, and environment). [Checkland, 1999]

However, even the subdivision into nine elements leaves questions about terms, such as whether technology is part of the work practices rather than something used by the work practices, how to differentiate between technology and technical infrastructure, and whether to treat managers as participants, as customers, or as something else. Despite these questions, extensive experience with reports by MBA and EMBA students shows that the work system framework makes enough sense to support the initial analysis of a system in a real world organization.

Table 2 lists the slices in the current version of Sysperanto. (Visualizing work systems in terms of nine elements is so pervasive in Sysperanto that Figure 4 treats the subdivision into elements as an inherent part of Sysperanto's structure rather than as one of many possible slices of a work system.) As Sysperanto develops further, additional slices will be added for the elements themselves, for "sub-slices" within a slice for a particular work system element, and for the elements of special cases such as information systems, projects, and supply chains.

Table 2. Slices Included in the Current Version of Sysperanto

Element of a Work System	***Slices Relevant to this Element***	***Comments about the Slices for this Element***
Work practices	• Work practices as a whole • Business process • Control • Communication • Sense making • Decision making • Coordination • Information processing • Thinking • Physical actions	*Work practices as a whole*: properties concerning work practices as whole, rather than more specialized slices. *Business process, control, communication, sense making, decision making, coordination, information processing, thinking, physical actions*: Each of these slices brings concepts and generalizations that apply to the work practices in many situations, but not all.
Participants	• Individuals • Groups • Roles • Impacts on participants • Impacts of participants	*Groups and individuals:* properties concerning participants viewed as groups of people or individuals *Roles*: properties related to participant roles, without specific reference to identity or characteristics of individuals. *Impacts on/of participants*: Impacts on/of rather than inherent properties of individuals, groups, or roles.
Information	• Information as a whole • Database • Documents • Speech • Knowledge • Workspace signals and cues	*Information as a whole*: properties related to all or a subset of the information in a work system, without separately referring to characteristics of different types of information such as database information or documents *Database, documents, speech, knowledge, workplace signals and cues*:

		Even though the growth of multimedia has generated some disagreement about basic definitions of terms such as database or document, some separate concepts exist for each of these types of information. Also, although speech might not seem to belong in the same category as database, documents, or knowledge, much of the information in meetings and other coordination activities can be viewed as conversation or speech acts.
Technologies	• Technology as a whole • Artifacts (tools) • Techniques • Interfaces	*Technology as a whole*: Properties related to all or a subset of the technologies in a work system, without separately referring to properties of particular types of technologies. *Artifacts and techniques*: Technologies can be viewed as artifacts, techniques, or techniques inscribed on artifacts. Most of the concepts for technologies may be related to artifacts or techniques rather than technologies as a whole. *Interfaces:* Technologies that are visible to users typically have interfaces through which users guide the technology or receive information from it.
Products and services	• Products and services as a whole • Physical product • Information product • Service • Social product • Intangible product • By-product • Waste • Customer experience	*Products and services as a whole*: Properties related to all or a subset of the products and services produced by a work system, without separately referring to properties of particular types of products and services. *Physical product, information product, service, social product, intangible product, by-product, waste, customer experience*: Some important concepts refer specifically to each of these aspects of the products and services produced by a work system.
Customers	• Individuals • Groups • Roles • Impacts on customers • Impacts of customers	*Groups or individuals*: properties concerning customers as groups of people or individuals *Roles*: properties related to customer roles, without specific reference to identity or characteristics of individuals. *Impacts on/of customers*: Impacts on/of rather than inherent properties of individuals, groups, or roles.
Infrastructure	• Infrastructure as a whole • Human infrastructure • Information infrastructure • Technical infrastructure	*Infrastructure as a whole*: properties related to all or a subset of the infrastructure supporting a work system, without separately referring to properties of particular types of infrastructure. *Human, information, and technical infrastructure*: Some separate concepts may apply for each of these.
Environment	• Environment as a whole • Culture • Political environment • Competitive environment • Policies and procedures • Regulations and standards • History	*Environment as a whole*: Properties related to all or a subset of the environment surrounding a work system, without separately referring to properties of particular aspects of that environment. *Culture, political environment, competitive environment, policies and procedures, regulations and standards, history*: Some separate concepts may apply for each of these separate aspects of the environment.

Strategies	• Strategies as a whole • Work system's strategy • Organization's strategy • Firm's strategy	*Strategies as a whole*: properties related to all or a subset of the strategies that affect a work system, without separately referring to properties of particular levels of those strategies. *Strategy of the work system, organization, and firm*: Some separate concepts may apply for each of these separate levels of the relevant strategies.
Work system as a whole (listed here for completeness even though a work system is not an element of itself)	• Work system as a whole • Work practices • Participants • Information • Technology • Products & services • Customers • Environment • Infrastructure • Strategies	*Work system as a whole*: Although most slices and properties are related to elements of work systems, some are related to a work system as a whole. For example, a work system's age, criticality, fragility, and capacity are related to the work system as a whole rather than its individual elements. *Work practices, participants, information, technology, products & services, customers, environment, infrastructure, strategies*: Because the elements of a work system are a top level slice, they are so fundamental to Sysperanto that they are treated as a separate part of its structure.

PROPERTIES

For a work system of any type, properties of the entire work system and of individual elements of the work system can be used for system description and analysis. A specific property may be a mathematically derived quantity (e.g., average age or diversity of participants), a qualitative judgment about the inherent nature of an aspect of the system (e.g., degree of structure or complexity), or an emergent property that depends on interactions (e.g., group cohesiveness). For convenience, each property of a work system element (or of the entire work system) is assigned to a particular slice.

To illustrate, Table 3 identifies different types of properties and gives examples within each type for the "work practices as a whole" slice of the "work practices" element of work systems in general. Among the various types of properties,

- components and phenomena are like nouns;
- actions and functions are like verbs;
- characteristics are like adjectives (inherent features related to form and structure that tend to persist until changed);
- performance indicators are like adverbs (describing how well something was done or what its status was during a particular event or time interval); and
- relationships involve topics linking two or more things (such as overlaps, dependencies, complementarities, compatibility, and interoperability).

For work system subtypes such as information system or project, the" work practices as a whole" slice of the "work practices" element will inherit many of the properties in Table 3, but might also possess other properties that are not properties of work systems in general.

Table 3. Property Types and Examples of Related Properties for the "Work Practices as a Whole" Slice of the "*Work Practices*" Element of a Work System

Property Type	***Examples of Properties for the "Work Practices as a Whole" Slice of the "Work Practices" Element of a Work System***
Components and phenomena	• Norms and values inherent in the work practices • Mutual awareness between participants • Pre-computation (creating checklists, plans, and other aids so that people won't need to figure things out on the fly)

Actions and functions	• Initiate (trigger) • Plan • Set-up • Execute • Repair/ rework • Complete (packaging for next step or for customer) • Control (feedback) • Coordinate • Track (perform record keeping) • Manage
Characteristics	• Degree of structure • Range of involvement • Level of integration • Complexity • Degree of variety • Degree of automation • Rhythm • Degree of attention to planning and control • Error-proneness • Formality of exception handling • Degree of improvisation • Degree of interruption
Performance indicators	• Rate of activity • Rate of output • Consistency • Productivity (e.g., cost per unit) • Value added • Speed • Downtime • Vulnerability • Rate of rework
Relationships	• Produces for: Customer, Upstream process • Receives from: Supplier, Downstream process • Initiated by: Triggering event • Governed by: Rule, policy • Limited by: Constraint • Dependent on: another process or something else • Interdependent with: another process or something else
Change-related actions	• Adaptation • Workaround • Experiment
Change-related characteristics	• Adaptability (vs. rigidity)
Change-related performance indicators	• Amount of effort to make a change • Amount of effort in relation to the extensiveness of a change
Generalizations	• If the degree of structure is too high, work system participants are prevented from using their judgment; if it is too low, foreseeable errors are more likely to occur because rules are not applied consistently. • If complexity is too high, participants may not understand what they are doing or why; if it is too low, the work practices may not distinguish between cases that should be handled differently.

Table 3 presents properties related to the “work practices as a whole” slice for the “work practices” element of a work system. Other slices for work practices, such as business process, communication, sense making, coordination, and decision-making (Table 2) would add other properties for each slice. For example, the communication slice would add degree of social presence and degree of synchronicity as two characteristics of a communication situation and would add clarity and degree of absorption by the recipient as performance indicators. These properties apply in most communication situations even though they would not be considered characteristics or performance indicators for work systems in general.

PARTIAL INHERITANCE

Figure 3 illustrated the idea of inheritance by showing that success factors for work systems in general should be inherited by special cases of work systems such as information systems and projects. Each of these systems might involve additional success factors related to their unique properties.

Figure 5 extends the meta-model characterization in Figure 4 by illustrating how partial inheritance says that subtypes inherit some, but not necessarily all, elements, slices, and properties from supertypes. The relative size of the boxes for inherited and non-inherited elements, slices, and properties in Figure 5 reflects a belief that most of the important slices and properties for subtypes are inherited from the most similar supertypes. Conversely, Figure 5 says that relatively few slices or properties relevant to supertypes are not inherited by subtypes. Additional slices and properties may also be relevant due to the unique nature of each special case. For example, the process of defining international MIS as a work system type in Sysperanto would start by assuming that the slices and related properties for the work system type MIS would apply. The next step would involve considering whatever is unique about international MIS, and then removing inappropriate slices and properties that apply to MIS in general and adding slices or properties needed for international MIS.

Sysperanto's structure will prove valuable in situations such as this example if most of the slices and properties from the supertypes actually are relevant (and therefore can be inherited) and if these far outnumber the slices and properties unique to the subtypes. Stretching the point a great deal, this view is analogous to the finding in biology that the structure of mouse DNA is substantially similar to the structure of human DNA.

CHALLENGES IN IDENTIFYING APPROPRIATE SLICES AND PROPERTIES

The many challenges in developing Sysperanto include identifying the right slices and putting them in appropriate locations in relation to the type of work system, work system element, and slice. The payoffs, however, should include greater ability to codify knowledge within IS, teach that knowledge, and incorporate that knowledge into tools for analyzing and designing systems.

The inclusion or exclusion of specific property types and properties in Table 3 illustrates some of the challenges in developing Sysperanto. Table 4 lists specific issues and gives examples based on previous tables.

V. COMPARISON OF SYSPERANTO WITH OTHER PARTS OF THE IS LITERATURE

Fully understanding Sysperanto's approach and feasibility requires a comparison of Sysperanto with other ideas in the IS literature. Figure 6 provides a two-dimensional framework for making these comparisons. It uses the framework to compare Sysperanto (which is being developed), the work system framework (used in several versions in teaching since 1996 and more recently in research[10]), and the work system method (first published in 2002 and extended since then). The two dimensions of the framework are extensiveness and guidance in application.

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[10] For example, Ramiller [2002] and Petrie [2004].

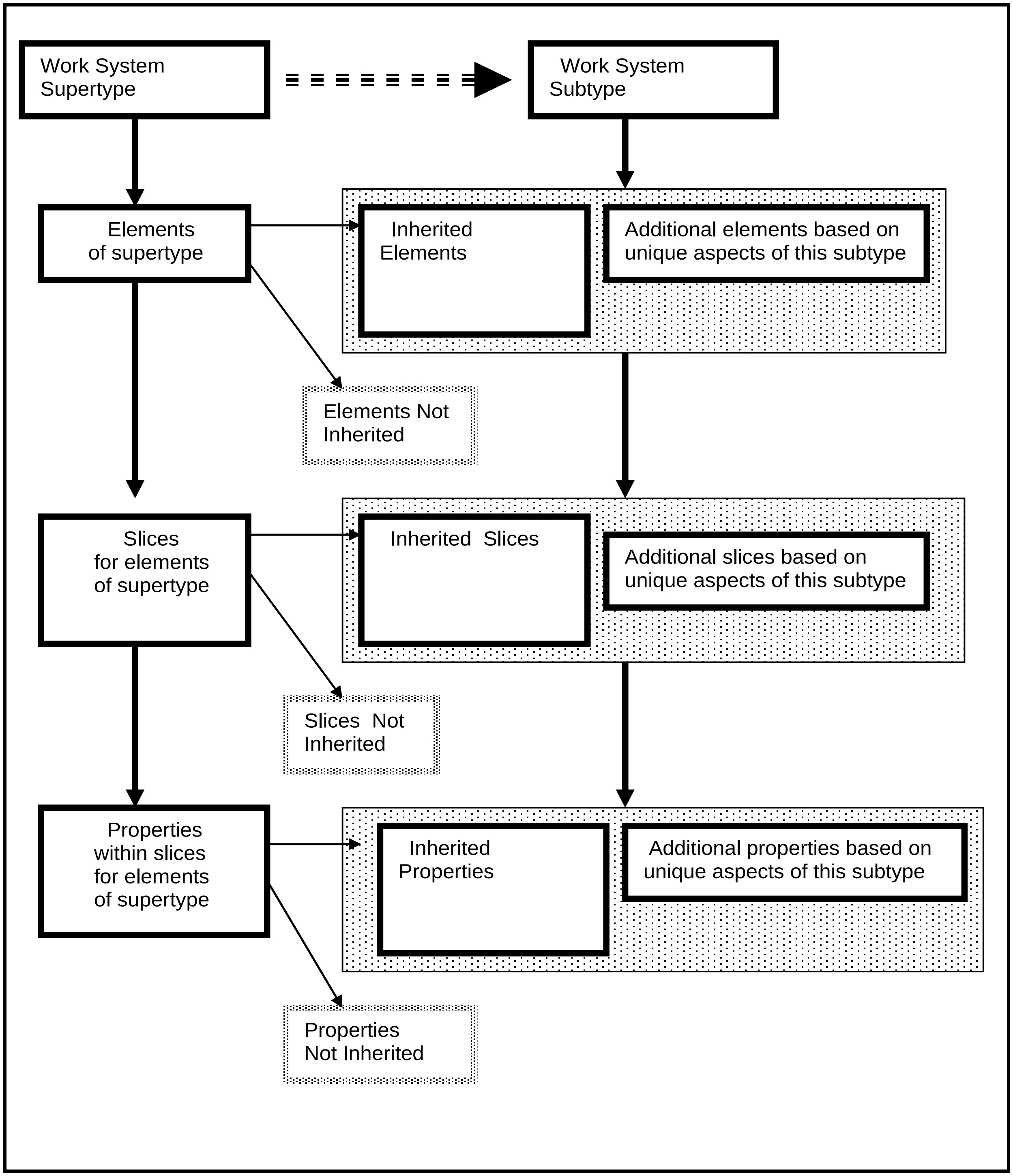

Figure 5. Partial Inheritance

Table 4. Examples of Challenges and Issues in Developing Sysperanto

Challenge or issue	Examples
Which property types to include?	• Table 3 includes the property type *performance indicator* but not measures of performance because one performance indicator might require multiple measures of performance. Should measures of performance be included at the same level? • Table 3 includes three property types related to changes in a work system. In contrast, *components and phenomena, actions and functions, characteristics, performance indicators*, and *relationships* are all about the operation of a work system. Should the change-related property types be included?
Which properties to include within each property type?	• The *work practices* properties in Table 3 under the property type *actions and functions* include initiate, plan, set-up, execute, repair/rework, complete, control, track, and manage. Each term might be replaced by synonyms or related terms. How many different actions/functions are needed, if any? How should synonyms be handled? • Table 3 includes the property degree of structure. Is this a synonym of task uncertainty or is it a different concept?
What about phenomena that involve impacts of one element on another?	• Impacts of the work system on participants raise important practical and ethical questions. Where do topics such as feelings of autonomy and incidence of fatigue, frustration, and fear belong? These are about interactions between the work practices (or possibly the entire work system?) and the participants. Or perhaps they should be treated at the element level as a separate "interaction element" (as indicated by the two-headed arrows in the work system framework in Figure 1). Alternatively, perhaps they should be included as a special type of property linked to a specific element.
Where do some basic phenomena belong?	• Where does history belong? Should it be a property type related to a *work system as a whole*, or does it make more sense to associate history with each element or to assume that history is a component of one specific element, *environment*? • CSCW researchers discuss the importance of physical layout, common field of work, common information space, and boundary objects. Should these be associated with work systems as a whole or are they related to the work practices? Should they be included at all?
What about distinctions between work systems in operation versus ongoing changes in a work system's structure?	• Work systems exist in a particular form during a particular time interval and evolve through planned and unplanned change. According to the work system life cycle model [Alter, 2003a], planned change can be described as iterative cycles of four phases (operation and maintenance, initiation, development, and implementation) and occurs through projects (a type of work system). Unplanned or emergent change occurs through insights, experimentation, and adaptations accomplished without major projects or major allocation of resources. Sysperanto currently handles change using the property types *change-related actions, change-related characteristics,* and *change-related performance indicators*. Is there a better way to handle planned versus unplanned change?

Guidance in application refers to the extent to which a particular set of ideas tells a user of those ideas what to do and how to do it. This dimension starts with concepts, frameworks, and domain ontologies, which provide successively more guidance about the ideas to use for thinking about a particular situation or type of situation. Domain ontologies are often more prescriptive than frameworks because they identify and organize ideas that can or should be used. Methods are more prescriptive yet because they guide or dictate action. Less structured methods guide the use of human judgment, whereas the most structured methods are algorithms designed to produce mathematically defined outputs based on specific inputs.

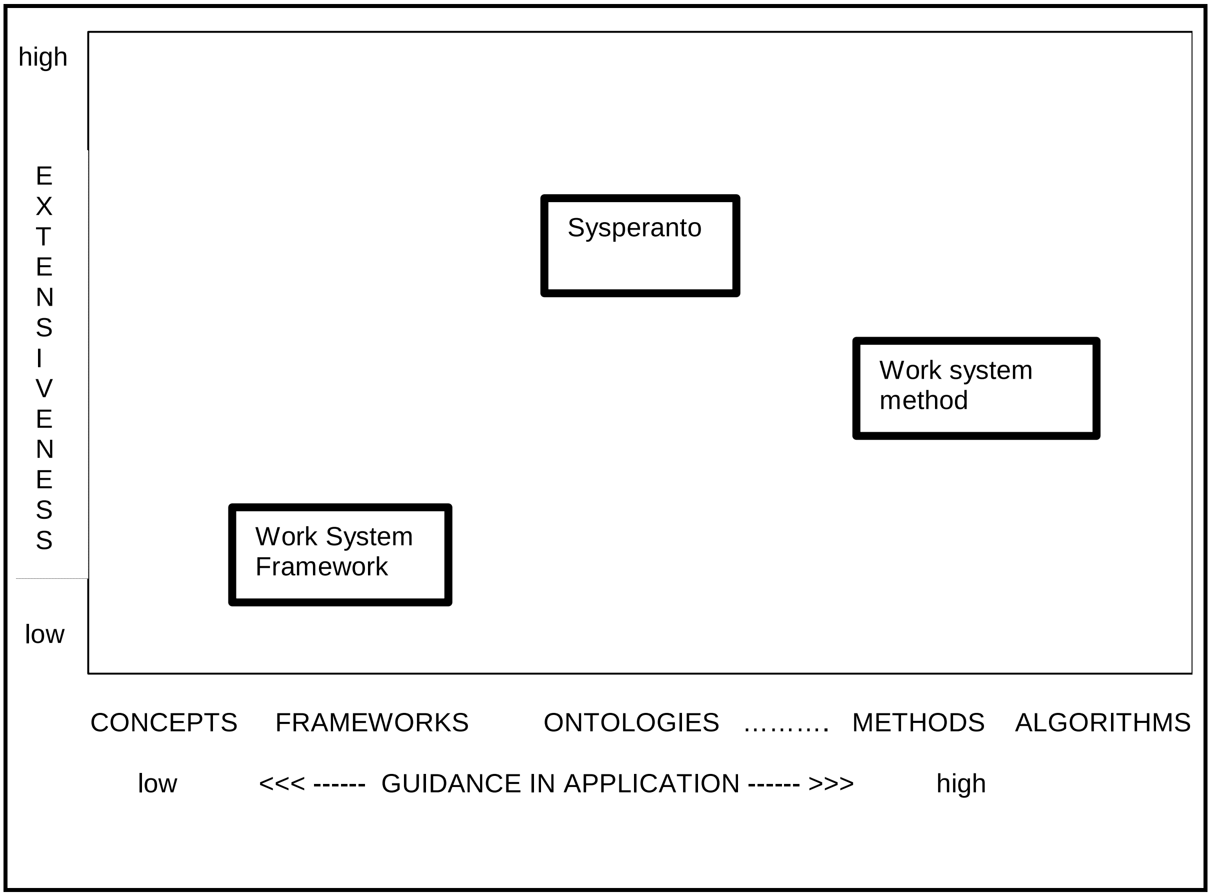

Figure 6: Comparing Sysperanto, the Work System Framework, and the Work System Method

Extensiveness refers to the number of ideas included in a particular framework, ontology, or method. For example, a typical 2 X 2 framework is basically a comparison of four ideas, whereas a method for producing high reliability software typically contains many more ideas. The intended extensiveness of Sysperanto is apparent from the large number of slices in Table 2 and the large number of terms included in Table 3 just for the slice called "work practices as a whole." Although most slices will contain fewer properties than Table 3, it is clear that a large number of slices will be involved and that most will contain more than several properties.

The relative location of Sysperanto, the work system framework, and the work system method in Figure 6 reflects differences among their goals. The nine elements in the work system framework and the underlying logic provide a rationale for summarizing a work system in terms of a relatively small number of concepts. Sysperanto is more extensive because it contains hundreds of concepts. It also provides more guidance for action because it organizes those concepts in a way that supports their use. The most recent (but not yet published) version of the work system method uses many concepts included in an initial draft of Sysperanto. The method itself provides more guidance than Sysperanto because it outlines steps for analyzing a system. Even when developed further, however, it will be less extensive than Sysperanto because Sysperanto will contain some IS concepts that are not directly applicable to analyzing a work system.

Figure 7 builds on Figure 6 by comparing Sysperanto with selected sets of ideas from the IS and computer science literature. The figure is basically a positioning map of the type used in marketing to compare products. The location of the various boxes is an attempt to indicate the relative positioning of chunks of the literature that are vastly different in size, form, and purpose. For example, Sysperanto is an ontology that contains hundreds of terms related to systems in organizations, whereas Cyc currently contains over a million hand-coded assertions that attempt to capture many aspects of common sense about the everyday world. [Cycorp, 2004a]. Accordingly, Sysperanto's position in Figure 7 is closer to that of enterprise and organization ontologies. Similarly, the work system method is closer to soft systems methodology, UML, and the system development life cycle and further from the semantic Web. To provide more clarity about Sysperanto's goals and scope, Appendix 3 explains how the various sets of ideas in Figure 7 are comparable to Sysperanto and how they differ from it. The length of Appendix 3 illustrates that a complete discussion of everything in the Figure would be a very long article by itself.

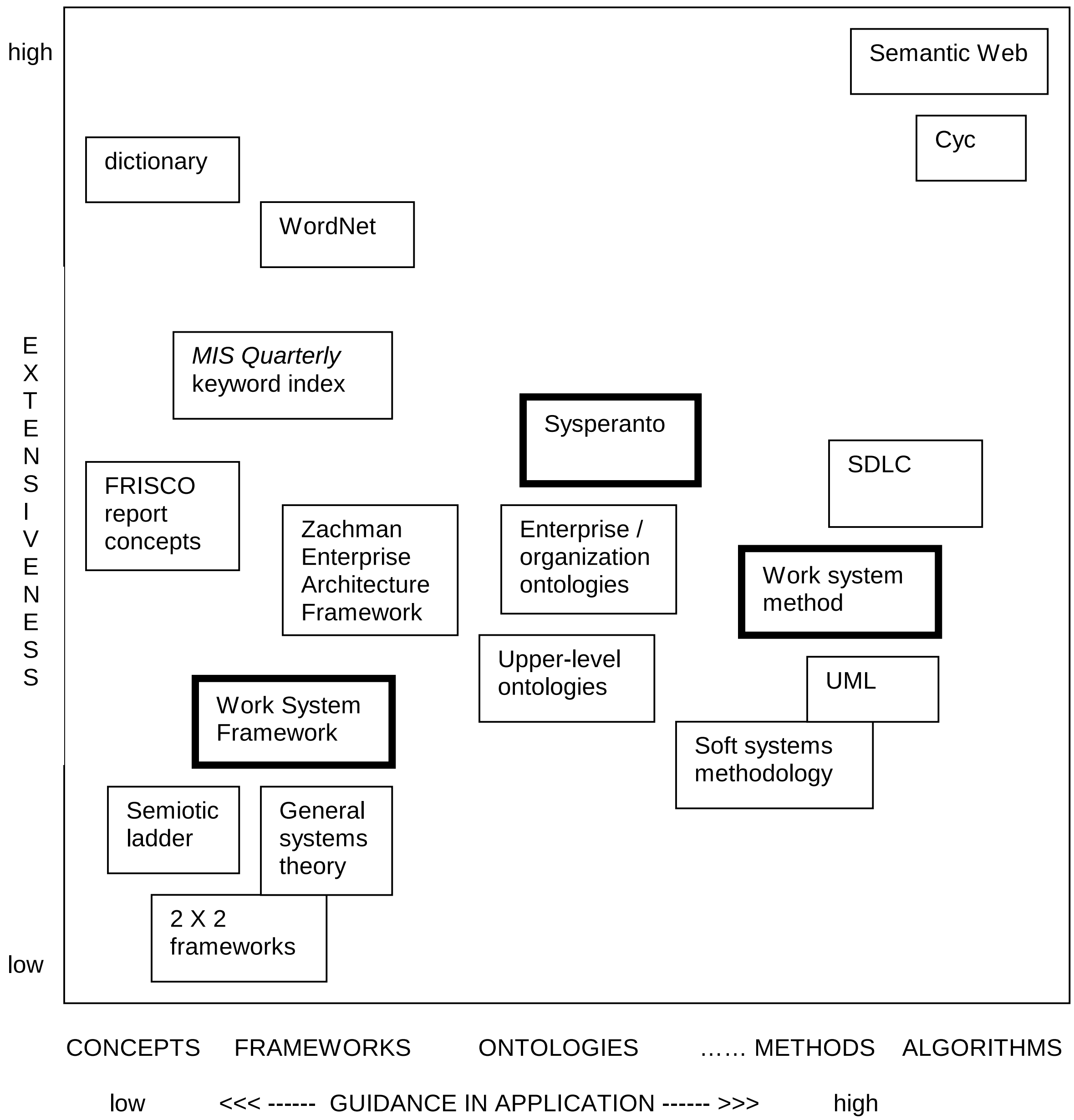

Figure 7: Comparing Sysperanto with Other Sets of Ideas in the IS Field

VI. DISCUSSION

The development of Sysperanto can be viewed as a long-term design research effort [Walls et al, 1992; Hevner et al, 2004; Markus et al 2002]. As the ontology underlying the work system method, Sysperanto's goals include supporting understanding and analysis of systems by people, supporting communication between people, and facilitating the use of knowledge about systems in organizations. Based on these goals, the architecture of Sysperanto:

- is designed to organize system-related vocabulary that can be used by typical business professionals, not just Ph.D. researchers
- is based on a "common denominator" for understanding most systems within and across organizations, including information systems, projects, supply chains, and e-commerce web sites
- shifts the primary level of analysis from information system concepts to work system concepts
- cannot require a strategic or enterprise-wide viewpoint because most systems in organizations are neither strategic nor enterprise-wide[11]
- treats people as participants in systems rather than users of systems
- attempts to go beyond idealized views of systems by including socio-technical issues, individual differences, adaptations, exceptions, and workarounds[12]
- applies inheritance of properties in a potentially valuable way
- provides a new meta-model and related terminology
- is the basis of several challenging conjectures about the nature of knowledge in the IS field
- provides a contrast with other frameworks, methods, and tools that try to address important problems in the IS field.

Sysperanto's architecture is designed to establish the discipline of working from a formal ontology while also encompassing diverse viewpoints such as decision making, communication, information processing, and human motivation. The interplay of viewpoints is important because many systems are best understood by considering concepts, generalizations, and dilemmas associated with different viewpoints. Encouragement of diverse viewpoints pushes Sysperanto's architecture toward use of partial inheritance and multiple, partially overlapping slices. Unfortunately, a different architecture based on strict inheritance (rather than partial inheritance and partially overlapping slices) would have made it easier to build interactive tools that perform automatic inference while supporting an analysis process.

WILL SYSPERANTO BE RIGOROUS ENOUGH?

The main challenge in developing Sysperanto is to identify the most appropriate and powerful concepts and to classify them at the right level in the ontology. Although Sysperanto should be rigorous and organized enough to help people use ideas from many viewpoints, it should avoid unnecessarily constraining the way people use slightly vague or partially overlapping concepts in reference to particular situations. Clear concepts are obviously preferable to vague or

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[11] Therefore its granularity should be finer than that of enterprise models such as Zachman's Framework for Enterprise Modeling [Zachman, 1998] and Frank's Multi Perspective Enterprise Modeling Framework [Frank, 2002].

[12] Typical workflow concepts [Stohr and Zhao, 2001] for specifying idealized business processes (i.e., as those processes are designed to occur) should be included. However, consistent with Suchman's [1987, p. 52] observation that "plans are resources for situated action, but do not in any strong sense determine its course," it should not emphasize idealized system development methods while downplaying the common deviations that occur in practice. Similarly, it should not suppress the fact that different individuals may perform the same business process step differently even if they are trying to do it the same way.

inconsistent concepts. However, Sysperanto should not force the use of concept hierarchies or taxonomies that are less useful to most people than the ideas that they use every day.

The question of how much rigor is needed in Sysperanto can be appreciated by comparing it to conceptual modeling, an area of the IS field in which considerable effort has been devoted to defining concepts that are both precise and useful. Conceptual modeling methods are used in analyzing and designing transaction processing systems, just as the work system method and Sysperanto are designed to help people describe and analyze IT-reliant work systems (a broader goal). In their *ISR* research commentary on conceptual modeling, Wand and Weber's [2002] say that their fundamental question is "How can we model the world to better facilitate our developing, implementing, using, and maintaining more valuable information systems?" An almost identical question about creating and improving work systems (rather than just information systems) motivated the development of Sysperanto.

Concerns about modeling precision are a key issue in much of the research about conceptual modeling. In contrast, the effort to develop the work system method and Sysperanto is based on the assumption that better requirements will come from broadening the analysis rather than establishing and enforcing greater precision. Broadening the analysis implies focusing directly on factors beyond the scope of formal specifications and software. For example, Sysperanto's architecture encourages consideration of the idealized structure of current and proposed systems, but it also encourages consideration of practical issues such as:

- process and product performance,
- changing business needs,
- organizational politics,
- misalignment with culture,
- difficulties in organizational change,
- individual differences in capabilities,
- mismatched incentives,
- workarounds,
- errors and exceptions in performing work.

These factors are not captured in conceptual modeling specifications of an idealized system. Most of these factors are subjective and lack the precision expected in conceptual modeling. Although the treatment of these factors will be less rigorous than the treatment of data and process definitions, including them in the work system method and Sysperanto may add to the rigor and completeness with which analysts examine issues beyond the bounds of current conceptual modeling techniques. Whether explicit inclusion of these factors will generate higher project success rates and more successful systems remains to be seen.

Finally, notice that Sysperanto's inclusion of partially overlapping slices makes it more difficult to satisfy criteria computer scientists and philosophers might propose regarding the completeness and consistency of an ontology. For example, Colomb [2002] says that the quality of an ontology used for information system interoperability can be evaluated by asking three questions:

- Is the model syntactically correct?
- Does it cover the domain of interest? and
- Is it comprehensible by the users?

The question about syntactic correctness is secondary issue for Sysperanto because its main challenge is supporting the use of concepts by people rather than using concepts in automated inference. On the other hand, the questions about completeness and understandability are central to Sysperanto's emphasis on recognizable concepts that most business people can use directly when analyzing systems or communicating about them.

RELEVANCE TO IMPORTANT ISSUES IN THE IS FIELD

Even before Sysperanto is fully developed, Sysperanto's architecture can shed light on areas of concern in the IS discipline including its diffuse nature and lack of a conceptual core, its relationship to other fields, and tensions between rigor and relevance in IS research.

Defining the Core and Structure of the IS Field

Sysperanto's architecture outlines a new way to codify concepts and knowledge in the IS field. Representing an extremely broad view of the IS field, it starts with the work system framework, identifies slices and properties for each element, and assumes that most properties are inherited through subtype relationships. Going far beyond the typical assertion that the analysis of any system requires an understanding of the systems it serves, Sysperanto's architecture says that information systems are a special case of work systems and that much of the basic knowledge about information systems is actually knowledge about work systems in general.

Sysperanto's architecture presents a challenge for any alternative set of ideas proposed to represent the core and structure of the IS field. Detailed examination of any of the sets of ideas in Figure 7 would clarify which Sysperanto elements, slices, and properties are included and which are treated as externalities beyond the scope of that set of ideas. Therefore, regardless of whether an alternative approach is based on speech act theory, activity theory, enterprise models, soft system methodology, or other ideas, it should be possible to identify the areas of overlap and non-overlap with Sysperanto. For each area of overlap or non-overlap one might ask whether the inclusion or exclusion of specific concepts would probably help business and IT professionals understand and respond effectively to the realities of systems in organizations. It would also be possible to ask whether and how the areas of overlap and non-overlap would affect the potential value of IS research.

Dealing with the Proliferation of Relevant Topics

The architecture of Sysperanto is based on the assumption that all useful ideas should be welcomed and incorporated, regardless of their source, because the goal is to organize and codify concepts and knowledge that will help people understand and analyze systems in organizations. The realities encountered in creating and improving systems in organizations involve many issues often associated with computer science, organization behavior, individual and social psychology, accounting, operations management, marketing, decision science, strategy, and other fields. If the goal is better systems, it is counterproductive to reject or ignore ideas that were "not invented here." The practical value of any particular concept or bit of knowledge is much more important than whether it was initially defined by someone associated with a different discipline.

Wholehearted acceptance of Sysperanto's architecture would expand the scope of the IS field and would cause an increasing degree of overlap and sometimes even collision with other fields that provide relevant concepts and knowledge. Dissolving the IS silo in this way brings some practical risks for the status of the IS field in academia, but those risks seem smaller than the risk of trying to keep the silo intact and reducing the potential scope and value of IS research. The underlying hope is that consciously expanding the field's scope would promote the growth and long-term health of its focus on the analysis and design of systems in organizations, an area that no other discipline treats adequately. [Alter, 2003b]

It is not obvious how the IS field should treat relevant topics associated with these other disciplines. Many senior people in the IS field have debated the importance of establishing and protecting the IS field's unique turf, and argued that carelessness in this regard might erode the IS field and lead to its piecemeal absorption into other fields. (e.g., Benbasat and Zmud [2003]) On the other hand, erecting unduly restrictive boundaries would reduce the IS field's power and potential. Furthermore, Baskerville and Myers [2002, p. 1] argue that status as a reference discipline can be a two-way street, and that "perhaps the time has come for IS to become a reference discipline for others." Arguments about academic turf and the IS field's identity are beyond this paper's scope, but the proliferation of relevant topics is a key issue for any potential ontology of the IS field because the excluded topics are assumed to be unimportant or extraneous for the purpose at hand.

Implications for the Rigor versus Relevance Debate

Consideration of Sysperanto's architecture could also contribute to ongoing discussions of rigor versus relevance. Sysperanto's architecture was designed to strike a beneficial compromise between rigor and relevance. It is less rigorous than ontologies designed for computerized inference. It is far broader than tightly defined conceptual modeling tools that have a prescribed grammar.[13] It is designed to support analysis and design processes that operate through guidelines rather than through tightly constructed procedures. Sysperanto's inclusion and organization of a broad range of concepts and knowledge contribute to the work system method's usefulness in a large range of situations.

Most recent discussions of rigor versus relevance (e.g., [Benbasat and Zmud, 1999], [Davenport and Markus, 1999], [Koch et al, 2002]) ignore whether it is possible for a discipline to be rigorous when researchers apply different meanings to basic terms (e.g., inconsistent definitions of system, implementation, user, requirements). Even a sympathetic observer who recognizes the value of many individual research efforts might wonder about claims that IS is a discipline when it lacks a reasonably well-defined set of core concepts. The IS field cannot be as precise as physical science because it includes human, social, and organizational issues. However, the effort to create Sysperanto is a reminder that a reasonably well-defined core of ideas would support our claims that IS is truly a discipline.

VII. NEXT STEPS IN DEVELOPING SYSPERANTO

The development of Sysperanto faces a large number of challenges, the most straightforward of which were listed in Table 4. Those challenges are straightforward because they are mostly about details. If the difficulties of developing Sysperanto are mostly on that level, it is reasonably likely that a useful version will be produced in the next several years.

The next step in extending the partial prototype that currently exists is simply to flesh it out. The initial choices of what to include and where to include it (under which subtype, element, slice, and property type) will be subjective. Concepts will be selected by scanning personal libraries, journals, and articles available through the Internet. Each term selected should be of practical or theoretical significance in understanding, evaluating, analyzing, or designing systems in organizations. Terms such as complexity, coordination, and incentives will be included at the work system level, whereas terms such as CIO, Java, and extreme programming may be included under a work system sub-type or may not be included at all.

Subsequent work to extend and validate Sysperanto could involve any combination of the following steps performed in any order, preferably by IS researchers and practitioners who are not involved in the initial Sysperanto effort:

- Use personal knowledge and experience to review a current version of Sysperanto and identify missing, misplaced, and unnecessary concepts.
- Use a particular version of Sysperanto to organize major concepts and findings in a selected set of IS books and research articles and/or books from other disciplines such as computer science, organizational behavior, and marketing. Identify important concepts and knowledge

[13] Wand and Weber's [2002] framework for their research commentary on conceptual modeling is based on four concepts: the grammar (constructs and rules), the method (procedures for using the grammar), script (the product of conceptual modeling), and context (the setting within which conceptual modeling occurs).

that don't fit the current version and decide where they belong within Sysperanto's work system types, elements, slices, and properties.

- Identify concepts and findings that might be "promoted" to more general work system types. For example, research about a sample of CAD or ERP applications might provide concepts or generalizations relevant to information systems in general or work systems in general.
- After an initial version of Sysperanto is produced, review the ontology literature specifically related to IS to see how Sysperanto might be improved based on philosophical underpinnings that this paper only hints at. For example, the meta-model might be improved though a detailed comparison with the FRISCO report or upper-level ontologies such as those included in Table 5 in Appendix 3.

When fully developed, Sysperanto could help in codifying IS knowledge, building and improving systems, and motivating fruitful IS research. Achieving these goals would not require that everyone in the IS field master or use Sysperanto. Simply attending to the issues Sysperanto addresses and how it addresses them should help IS researchers and practitioners communicate with others, identify confusions, and interpret both accepted wisdom and research results.

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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 computer 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 I. DEFINITION OF CONCEPTS RELATED TO SYSPERANTO AND WORK SYSTEMS

This Appendix identifies basic concepts related to work systems and Sysperanto.

Appendix 2 defines the nine elements of a work system.

Work. Effort applied to accomplish something within an organization or across organizations.

Work system. A view of work as occurring through a purposeful system

Work system framework. This framework is a model for organizing an initial understanding of how a particular work system operates and what it accomplishes. It identifies the 9 elements required for even a rudimentary understanding of a work system.

Information systems and work systems. An information system is a particular type of work system. It is a work system whose work practices are devoted to processing information.

Organization versus work system. An organization typically consists of multiple work systems coordinated to accomplish goals that these work systems cannot accomplish individually. It is possible to view an entire organization as a single, large work system combining many independent or partly dependent work practices and groups of participants, but this is often not useful because too many different roles and work practices are combined.

Performance indicators. Multiple performance indicators may be associated with each element of the work system, and each of these indicators may include multiple measures of performance. The relative priority among the performance indicators for a particular work system may change from time to time.

Static view of a work system. How a work system operates, based on a particular configuration of the work system. Minor adaptations and workarounds may occur within that configuration.

Dynamic view of a work system. How a work system's configuration evolves over time through a combination of planned and unplanned change.

Work system life cycle. Process through which a specific work system is created and changes over time through planned and unplanned changes.

Work system life cycle model. Iterative four-phase model summarizing a typical work system's life cycle.

Partial inheritance conjecture. Possibility that most (perhaps 80% or more) of the elements, properties, and propositions for a specific work system type are inherited by more specialized work system types.

Reverse inheritance conjecture. Possibility that many findings in the IS literature that are not specifically about the unique components or properties of particular work system types are applicable to more general work system types.

Level-skipping conjecture: Possibility that most of the properties of information systems in general come from work systems in general, few additional properties are related to information systems in general, and many additional properties are related to the unique features of the special cases

Hierarchy of work system types. The general case is the work system in general.

- An information system is a work system whose work practices are devoted to processing information.
- A project is a work system designed to go out of existence after producing a particular product.
- A supply chain is an interorganizational work system whose participants include suppliers and their customers and whose work practices are devoted to establishing and fulfilling customer requirements.

Each of the special cases contains subordinate special cases.

Work system aggregations. Entire departments, organizations, communities of practice, firms, industries, geographic regions, and societies might be viewed as aggregations of work systems. These aggregations are beyond the current scope of Sysperanto even though various characteristics and performance indicators related to work system elements are used frequently at those aggregate levels.

Slices. A grouping of properties related to a particular element of a particular work system type. Slices may overlap because groups of properties may overlap.

Properties. The following types of properties apply to an entire work system or an element of a work system: components and phenomena, actions or functions, characteristics, performance indicators, relationships, change-related actions, change-related characteristics, change-related performance indicators, and generalizations.

APPENDIX II. DEFINITION OF WORK SYSTEM ELEMENTS

Work practices. The work performed within the work system can be summarized as one or more sets of work practices that may be defined tightly or may be relatively unstructured. In some cases, the work practices are divided into a sequence of steps that can be called a business process. In other cases, it is difficult to define sequences of steps but is still possible to talk about activities that occur. Activities within work practices may combine information processing, communication, sense making, coordination, decision-making, thinking, and physical actions. As workplace researchers point out repeatedly, the work that actually occurs often deviates from idealized business processes that were originally designed or imagined. In addition, different participants may perform the same business process steps differently based on their skills, training, and incentives.

Participants. People who perform the work are work system participants. Some may use computers and IT extensively, whereas others may use little or no technology. Whether or not particular participants happen to be technology users, when analyzing a work system the more encompassing role of participant is more important than the more limited role of technology user. (e.g., see Lamb and Kling [2003])

Information. Information includes codified and non-codified information used and created as participants perform their work. Information may or may not be computerized. Data not used in or generated by the work system is not directly relevant, making the distinction between data and information secondary when describing or analyzing a work system.

Technologies. Technologies include tools (such as cell phones, projectors, spreadsheet software, and automobiles) and techniques (such as management by objectives, optimization, and remote tracking) that work system participants use while doing their work. Even when substantially computerized, specific tools (such as cars) and techniques (such as use of checklists) may or may not be associated with IT. In terms of the work system framework, technologies are integral parts of the work system, and their affordances (such as a cell phone affording mobility) are evident to system participants. In contrast, technical infrastructure includes computer networks, programming languages, and other technologies shared by other work systems and often hidden or invisible to work system participants. In practice, the choice between treating something as technology or as infrastructure should depend on what is most meaningful in the situation.

Customers. People who receive direct benefit from products and services the work system produces may include external customers who receive the organization's products and/or services and internal customers who are employees or contractors working inside the organization. According to the principles of Total Quality Management, a work system's customers are typically best able to evaluate the products and services it produces. Customer satisfaction is often linked to the entire customer experience, starting from determining requirements and acquiring the products or services. In many work systems, different groups of customers may receive different products and may apply different criteria for evaluating those products.

Products & services. Products and services are the combination of physical things, information, and services that the work system produces for its various customers. They may include physical products, information products, services, intangibles such as enjoyment and peace of mind, and social products such as arrangements, agreements, and organizations. The terms products and services are used instead of "outputs" because that term brings too many mechanistic and computer-related connotations, especially when services and intangibles are involved.

Environment. Environment includes the organizational, cultural, competitive, technical, and regulatory environment within which the work system operates. (Environment includes the values, norms, agendas, and business conditions within "task context," the fourth of Benbasat and Zmud's [2003] four elements of an IT artifact.) Factors in the environment affect system performance even though the system does not rely on them directly in order to operate. The organization's general norms of behavior are part of its culture, whereas more specific behavioral norms and expectations about specific activities would typically be considered part of the work practices.

Infrastructure. Infrastructure includes human, informational, and technical resources that the work system relies on even though these resources exist and are managed outside of it and are shared with other work systems. Infrastructure includes support and training staff, shared databases, telecommunications networks, programming technology, and the Internet.

Strategies. Strategy is the guiding rationale and high-level choices within which a work system, organization, or firm is designed and operates. Although sometimes not articulated clearly, high-level choices about a system can often be inferred from plausible alternatives that were not chosen. For example, a system designed based on an assembly line rationale is not using a case manager rationale. Similarly, a system designed to operate based on mass customization is not using a commodity strategy. A work system's strategy should be aligned with the strategy of the organization and firm that it serves. For example, a work system designed to produce the highest quality outputs might not fit in an organization operating under a cost minimization strategy.

APPENDIX III: COMPARISON OF SYSPERANTO WITH THE VARIOUS SETS OF IDEAS IN FIGURE 7

To provide more clarity about Sysperanto's goals and scope, this Appendix explains how the various sets of ideas in Figure 7 are comparable to Sysperanto and differ from it.

Dictionaries: A dictionary is a list of words and their definitions. A key shortcoming of dictionaries is that they have no real structure. Words are simply defined in terms of other words. Dictionaries are usable only by people who know a language reasonably well. Sysperanto will be more than a dictionary because it is based on the work system framework and uses an inheritance-based structure to organize and codify concepts.

***MIS Quarterly* keyword index:** 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. Its top-level categories are reference disciplines, external environment, information technology, organizational environment, IS management, IS development and operations, IS usage, information systems, and IS education and research. Its purpose is to classify the topics in articles in an academic journal rather than to support evaluation, analysis, and design of systems in organizations. Consequently, it contains many terms that will be included in Sysperanto (such as task structure and complexity) and other terms that will not be included (such as IS research methodologies and IS recruiting).

FRISCO Report: In 1998 IFIP Task Group 8.1 published a report called "A Framework for Information System Concepts," [Falkenberg et al, 1998] which was intended "to provide a suitable conceptual framework" and "suitable terminology for the most fundamental concepts in the information system field, including the notions of information and communication, and of organization and information system." [p. 1] "The FRISCO report justifies the information system area scientifically by placing it in a more general context, comprising philosophy, ontology, semiotics, system science, organization science, as well as computer science. Thereby, the concepts of the information system area become 'rooted' or 'anchored', that is, related to concepts of these other areas. [p. 2].

Sysperanto will attempt to address the somewhat different goal of supporting system-related work and codifying knowledge about IS. It will assume everyday knowledge of the world and will not start at the same the level of abstraction or degree of concern about conceptual completeness and accuracy. For example, it will start with the terms in the work system framework and will not provide definitions for very basic terms that might afford completeness and clarity for computer scientists but that business professionals would not care to define. An example is the terms defined on pages 85-91 of the FRISCO report. The first ten of these are thing, predicator, predicated thing, relationship, set membership, elementary thing, composite thing, entity, type, and population. Typical business professionals would not be patient enough to use a framework starting on that level.

Zachman enterprise architecture framework: This framework is "a logical structure for classifying and organizing the descriptive representations of an enterprise that are significant to the management of the enterprise as well as to the development of the enterprise's systems." It is "a generic classification scheme for design artifacts, that is, descriptive representations of any complex object." [Zachman, 1998] The framework consists of 30 cells in a 6 X 5 format. The columns are data, function, network, people, time, and motivation, also described in the framework as what, how, where, who, when, and why. The rows are objectives/scope, enterprise model, model of the information system, technology model, and detailed representations. The various design artifacts are in the cells. For example, the design artifacts included with the business model include the semantic model (entities and relationships for data), the business process model (for function), the business logistics system (for network), the work flow model relating organizational units and work products (for people), the master schedule (for time) and the business plan (for motivation).

This enterprise framework lists tools related to many topics that will be included in Sysperanto in some form. However, as a classification scheme for design artifacts starting at the enterprise level, it serves a different goal than Sysperanto, which attempts to organize and codify the concepts needed to evaluate and analyze specific systems in organizations.

Semiotic ladder: The semiotic ladder is an example of a complex, philosophically based framework used in the part of the IS literature that attempts to identify fundamental concepts. As explained in the 1998 IFIP Task Group 8.1 report [Falkenberg et al, 1998, pp. 54-55 and 137-146] Stamper's semiotic ladder [Stamper, 1996] consists of six semiotic levels:

- social world: beliefs, expectations, commitments, contracts, culture, ….
- pragmatics: intentions, communication, conversations, speech acts, …
- semantics: meanings, propositions, validity, truth, signification, …
- syntactics: formal structure, language, logic, data, software, files, …
- empirics: pattern, variety, noise, channel capacity, codes, …
- physical world: signals, traces, physical distinctions, laws of nature, …

Although the IFIP report discussed and attempted to use these six levels, they will not be included in Sysperanto because they are too abstract for most business or IT professionals to understand or use.

2 X 2 frameworks: Whether 2 X 2 or 3 X 4 or 5 X 4, frameworks that make a particular comparison may be quite useful, but typically address only a small corner of the topics Sysperanto will cover. An example of a 2 X 2 framework is same/different time and place, often used when discussing IT applications in communication. The basic ideas from this type of framework or their synonyms will appear in Sysperanto because synchronous versus asynchronous and co-located versus geographically dispersed are common ideas for understanding systems in organizations.

General systems theory: The work system framework and work system method are partly based on general system theory, a set of concepts and statements that apply to all systems. General systems theory contains relatively few concepts, such as input, output, boundary, environment, and emergence. Although applicable to a huge range of situations, general systems theory has not proven rich enough or evocative enough to become a major influence on the way typical business and IT professionals analyze systems in organizations. Sysperanto will be far more extensive than general systems theory, and will try to provide both concepts and organization that will be of practical use.

Upper-level ontologies: An upper-level ontology is a domain independent ontology focusing on the most general classifications of concepts and is meant to be reusable across different domains. Table 5 presents four examples representing the types of concepts that appear in upper level ontologies. Many of the terms in Table 5 are meaningful only to people who studied fundamental issues about knowledge and knowledge representation. In contrast, Tables 2 and 3 show that the terms in Sysperanto are meant to be usable by typical business professionals attempting to understand, evaluate, or analyze a system in an organization.

For example, the Bunge-Wand-Weber ontology, the last of the four examples in Table 5, has been the basis of important research about whether current conceptual modeling techniques are ontologically complete and sufficiently rigorous. In contrast, the concerns underlying Sysperanto are about organizing ideas and helping people use ideas in real world situations where at least some degree of confusion, disagreement, and incomplete understanding is the norm. Under those circumstances, attaining a greater degree of organized analysis and communication is a major step forward; ontological purity is less important and perhaps impractical. Therefore

Sysperanto is being developed to be useful despite some degree of inconsistency and ambiguity in the way it is used. An underlying assumption is that most business and IT professionals cannot work at the level of abstraction and rigor required to appreciate the significance of BWW and other upper level ontologies, even though research on upper level ontologies may produce a more solid conceptual foundation for future modeling methods and tools.

Table 5: Examples of Concepts In Upper-Level Ontologies

Ontology	***Basic categories in the Ontology***
SUMO [Teknowledge, 2002]	SUMO, the standard upper level ontology, was developed by the IEEE Standard Upper Ontology Working Group. SUMO's content is divided into the following sections: physical distinctions, objects, processes, abstract entities, structural ontology, basic binary relations, numbers, measure, organic, temporal concepts, mereology, and semiotics. SUMO's top level taxonomy starts with entity, which is subdivided into physical and abstract entities. Physical entity: object or process …Object: self connected object (substance, corpuscular object, food), region, collection, agent …..Process: dual object process, intentional process, motion, internal change Abstract entity: set or class, relation, quantity, attribute, proposition, graph, graph element
KR Ontology [Sowa, 2001b]	As presented alphabetically in Sowa [2001b], the top level categories in Sowa's ontology for knowledge representation include: abstract, absurdity, actuality, continuant, description, entity, form, history, independent, intention, juncture, mediating, nexus, object, occurrent, participation, physical, process, prehension, proposition, purpose, reason, relative, schema, situation, and structure.
DOLCE [Masolo et al, 2002, Figure 2, p. 9]	DOLCE, the Descriptive Ontology for Linguistic and Cognitive Engineering) was developed as part of the WonderWeb project. The taxonomy of DOLCE's basic categories includes abstract quality, abstract region, accomplishment, achievement, agentive physical object, amount of matter, arbitrary sum, fact, feature, mental object, non-agentive physical object, non-agentive social object, physical quality, process, set, social agent, society, space, region, spatial location, state, temporal quality, temporal region, temporal location, time interval
Bunge-Wand-Weber ontology [Wand and Weber, 1990, Table 1, p. 64]	The BWW ontology contains the following constructs (in the order presented in Wand and Weber [1990]: thing, properties, state, conceivable state space, state law, lawful state space, event, event space, transition law, lawful event space, history, coupling, system, system composition, system environment, system structure, subsystem, system decomposition, level structure, external event, stable state, unstable state, internal event, well-defined event, poorly-defined event.

Enterprise or organization ontologies. A number of ontologies and models identify concepts related to enterprises or organizations. In contrast to ontologies that focus on very general terms related to knowledge representation, these ontologies and models have at least some of the application flavor of Sysperanto. The development of Sysperanto will include careful review of a range of these ontologies and models to identify concepts that should be included. Table 6 identifies three relevant examples, although there are certainly many others. It seems likely that Sysperanto will contain many more terms than most of these ontologies because it will try to encompass a range of concepts related to all nine work system elements. Schmidt and Simone's [1996] elemental categories in articulation work will contribute in some way to the concepts categorized under work practices in Sysperanto. The Enterprise Ontology [Uschold et al, 1998] will also contribute concepts related to activities and processes, organization, and strategy, although many of the terms it includes (such as legal ownership, employment contract, reseller, brand image, asking price) apply to specific types of work systems and do not apply to work systems in general. In addition, although Sysperanto will definitely include one or more performance indicators related to speed, it probably will not contain a separate category called time, and will not explicitly define certain terms that are included in the Enterprise Ontology, such as time line, time interval, and time point. Instead, these terms will probably be treated as part of the tacit real world knowledge possessed by any business or IT professional. Similarly, frameworks based on a language action perspective (e.g., [Goldkuhl and Rostlinger, 2002]) may contribute terms to Sysperanto.

Soft systems methodology: Widely used in the United Kingdom, SSM is a method for defining and analyzing system-related problems and opportunities. Checkland [1999, pp. A3-A15] notes that SSM evolved over three decades. An iterative seven-stage methodology [p. 163] emerged during the 1970s only to be revised (in Checkland and Scholes [1990]) as a process involving four activities [Checkland, 1999, p. A15]:

1. Finding out about the problem situation, including culturally, politically.
2. Formulating some relevant purposeful activity models
3. Debating the situation, using models that help in identifying changes that might improve the situation and accommodations between conflicting interests that will enable action-to-improve to be taken;
4. Taking action in the situation to bring about improvement.

Table 6. Examples of Ontologies and Models Related to Enterprises and Organizations

Ontology/ model	***Basic categories that are included***
Elemental categories in articulation work [Schmidt and Simone, 1996, p 190]	Schmidt and Simone [1996] outline an approach to CSCW systems based on coordination mechanisms. Figure 4 of their paper identifies "elemental categories of articulation work and their predicates." * Committed-actors assume, accept, or reject Roles; they initiate Activities. * Actors-in-action undertake, do, accomplish, or realize Tasks; they make publicly perceptible, monitor, are aware of, explain, question, or are aligned with Activities. * Articulation work includes classifying aspects of, monitoring, directing attention to, making sense of, or acting on an aspect of State of field of work. * Articulation work may show, hide content of, publicize, or conceal the existence of Informational resources-in-use. * Articulation work may deploy, consume, or transform Material resources-in-use. * Articulation work may deploy or use Technical resources-in-use. * Articulation work may use Infrastructural resources-in-use.
Enterprise Ontology [Uschold et al, 1998]	The Enterprise Ontology is a collection of terms and definitions relevant to business enterprises. It was developed in the Enterprise Project at the University of Edinburgh. It is divided into sections related to activities and processes, organization, strategy, marketing, and time. * Activity: Activity Specification, Execute, Executed Activity Specification, T-Begin, T-End, Pre-Conditions, Effect, Doer, Sub-Activity, Authority, Activity Owner, Event, Plan, Sub-Plan, Planning, Process Specification, Capability, Skill, Resource, Resource Allocation, Resource Substitute. * Organization: Person, Machine, Corporation, Partnership, Partner, Legal Entity, Organizational Unit, Manage, Delegate, Management Link, Legal Ownership, Non-Legal Ownership, Ownership, Owner, Asset, Stakeholder, Employment Contract, Share, Share Holder * Strategy: Purpose, Hold Purpose, Intended Purpose, Strategic Purpose,

	Objective, vision, Mission, Goal, Help Achieve, Strategy, Strategic Planning, Strategic Action, Decision, Assumption, Critical Assumption, Non-Critical Assumption, Influence Factor, Critical Influence Factor, Non-Critical Influence Factor, Critical Success Factor, Risk. * Marketing: Sale, Potential Sale, For Sale, Sale Offer, Vendor, Actual Customer, Potential Customer, Customer, Reseller, Product, Asking Price, Sale Price, Market, Segmentation Variable, Market Segment, Market Research, Brand Image, Feature, Need, Market Need, Promotion, Competitor. * Time: Time Line, Time Interval, Time Point
Three theories from a language action perspective [Goldkuhl and Rostlinger, 2002]	Goldkuhl and Rostlinger [2002] try to combine three theories developed from a language action perspective: Business action theory (BAT) is a theory concerned with the business interaction between customer and supplier." It describes six generic phases of business interaction plus communicative actions. The Theory of Practice (ToP) "gives a relational and conceptualized description of an organization or some part of it" and emphasizes different "governance forces" of a work practice, i.e. external assignments (from customers), internal assignments (from management), external and internal norms, and instruments used in the work practice Information Systems Actability Theory (ISAT) views IS as action systems, and conceptualizes different use situations: interactive, automatic and consequential use situations.

In addition to having goals similar to those of the work system method, SSM calls for thinking about the "root definitions" of systems in terms of a particular set of elements somewhat similar to those of the work system framework. The corresponding elements in SSM have the acronym CATWOE, which stands for customers, actors, transformation process, Weltanschauung (world view), owner, and environmental constraints. A goal of the work system method is to be more prescriptive than SSM through the inclusion and explicit use of work system principles, design characteristics, performance indicators, and other types of work system properties.

UML: Unified Modeling Language is a set of tools that support modeling efforts prior to and during software development. The twelve types of diagrams identified on the Object Management Group's web site are divided into three groups. Structural Diagrams include the Class Diagram, Object Diagram, Component Diagram, and Deployment Diagram. Behavior Diagrams include the Use Case Diagram, Sequence Diagram, Activity Diagram, Collaboration Diagram, and Statechart Diagram. Model Management Diagrams include Packages, Subsystems, and Models. [Object Management Group, 2003]

Although some of the ideas incorporated into those diagrams will be incorporated into Sysperanto in some fashion, analysis and design via UML differs substantially from the work system method, which may be applied whether or not IT is used extensively. The work system method focuses on the work system and defers until the recommendation stage any distinction between the work system and the information system that supports it. In contrast, the UML term "use case" implies that the goal is to build a technical artifact (the information system) that will be used in various predictable ways in particular business process situations. In addition, the work system method, and hence Sysperanto, will have to include many topics that are typically considered beyond the scope of conceptual modeling. For example, as a sociotechnical approach it will have to deal explicitly with participant-related topics such as incentives, skills, interests, and even fatigue and boredom. Such topics are not part of UML, which focuses on defining technical requirements in a precise form that supports software development or modification.

System development life cycle: Many different forms of the SDLC have been described. SDLC models are basically project models from the viewpoint of the IT professional managing the project and trying to produce the intended functionality within schedule and budget. Sysperanto will treat the SDLC as a particular type of project. Sysperanto will include some, and perhaps all

SDLC terms. The more general terms should appear at the work system or project level in the hierarchy rather than at the level of a specialized type of IS project.

WordNet: "WordNet is an extremely large and freely available online database. The database is divided by part of speech into nouns, verbs, adjectives, and adverbs. The nouns are organized as a hierarchy of nodes, where each node is a word meaning, a synset as it is termed in WordNet. A synset is simply a set of English words that express the same meaning in at least one context. For example, {accession, addition} is a synset, which expresses the meaning of adding to something. In version 1.6 of WordNet, there are 66,054 noun synsets, 17,944 adjective synsets, 3,604 adverb synsets, and 12,156 verb synsets." [Niles, 2002] Sysperanto's concept map will be far smaller than WordNet because Sysperanto's domain is limited to concepts related to systems in organizations. Sysperanto will have to include provisions for synonyms, but it is not clear whether it will be necessary to adopt conventions and notations like those in WordNet.

The Cyc knowledge base: The effort to computerize common sense by building the Cyc knowledge base began at a research consortium in 1984 and was spun off as Cycorp in 1995. "The Cyc knowledge base (KB) is a formalized representation of a vast quantity of fundamental human knowledge: facts, rules of thumb, and heuristics for reasoning about the objects and events of everyday life. … At the present time, the Cyc KB contains nearly two hundred thousand terms and several dozen hand-entered assertions about/involving each term. New assertions are continually added to the KB by human knowledge enterers." [Cycorp, 2004a]. For example, "Cyc knows about thousands of types of human activities. Here are a few of the facets (or organizing properties) by which human activities are distinguished:

- number of doers - single-doer activity, multi-doer activity (e.g. two-doer, group)
- thing acted on - inanimate object, animal (e.g. human), organization
- effect - human creation activity, human destruction activity
- thing used - human using a device, human using an animal" [Cycorp, 2004b]

Sysperanto's goals are far less ambitious than those of Cyc and it will be far less extensive because its domain is far smaller. Also, Cyc products are designed for automated inference, whereas Sysperanto is designed to organize system-related concepts to support use by people.

Semantic Web: The semantic web is a vision of what the Web could be in the future if genuine interoperability could be achieved at the data level. Requiring capabilities far beyond XML, the Semantic Web would use ontology-based brokers that could perform inferences to reconcile differences in data definitions between machines or automated processes that are attempting to communicate but do not share identical data definitions. [Berners-Lee et al, 2001]

As with Cyc, the Semantic Web is worth mentioning only to point out that Sysperanto's goals are far more modest. Sysperanto's goals may be very difficult to achieve, but they are orders of magnitude smaller than the long-term dreams that Semantic Web researchers are pursuing.

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Steven Alter is Professor of Information Systems at the University of San Francisco. He holds a B.S. in mathematics and Ph.D. in management science from MIT. He extended his 1975 Ph.D. thesis into one of the first books on decision support systems. After teaching at the University of Southern California he served for eight years as co-founder and Vice President of Consilium, a manufacturing software firm that was acquired by Applied Materials in 1998. His roles at Consilium included starting departments for customer service, training, documentation, technical support, and product management. Upon returning to academia, he wrote an information systems textbook that is currently in its fourth edition, *Information Systems: Foundation of E-business*. His research concerns developing systems analysis concepts and methods that can be used by typical business professionals and can support communication with IT professionals. His articles appear in *Harvard Business Review, Sloan Management Review, MIS Quarterly, European*

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