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Including Work System Co-Existence, Alignment, and Coordination in Systems Analysis and Design

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ABSTRACT

Interactions between systems constitute a common source of difficulty and complication in building, implementing, and maintaining IT-reliant work systems in organizations. Although a great deal has been published about systems analysis and design, most of the attention in that literature focuses on creating software specifications for a specific IT system. Relatively little attention focuses on direct and/or indirect interactions and conflicts between the IT-reliant work systems through which organizations operate.

This paper proposes that work system co-existence, alignment, and coordination should receive more attention in systems analysis and design. Its main contribution is an initial set of taxonomies related to work system co-existence, alignment, and coordination. Key concepts include system interactions, intentionality of interactions, directness of interactions, explicitness of interactions, persistence of interactions, alignment of work systems, and congruence of work systems.

Keywords

Systems analysis and design, alignment, organizational design, coordination theory, interaction design, work system

A MAJOR GAP IN SYSTEMS ANALYSIS AND DESIGN

Regardless of how well an IT-reliant system in an organization is constructed internally, direct and indirect interactions with other systems can cause that system's performance to degrade or even fail catastrophically. Relevant examples include:

- unnecessary stress on security systems when employee termination systems fail to terminate computer accounts,
- medical diagnosis systems that perform unnecessary tests because of the lack of access to medical electronic records systems of the patient's previous doctors,
- overtime in shipping departments when manufacturing output surges at month-end due to scheduling and control problems within the manufacturing department,
- audit systems that diminish sales results by absorbing too much time from sales systems in sales departments.
- work systems in one department that cause morale problems in other departments whose work systems seem to have unfair differences in work conditions, management, promotion, and other factors.

In each of these cases, the system is not just computer system. It is an IT-reliant work system in which human participants perform work using information and technology to produce products and services for the system's internal and/or external customers (Alter, 2006; 2008a; 2008b). Almost all work systems in current business organizations rely heavily on IT. Information systems are a special case of work systems in which all of the activities involve processing information. Projects, supply chains, ecommerce, and many other prominent system types can also be defined and analyzed as work systems.

Systems theorists such as Checkland (1999) and Ackoff (1994) have observed that systems typically exist to serve other systems and that understanding or analyzing a system requires an understanding of whatever systems are being served and how those systems are being served. The examples above illustrate why a thorough analysis needs to go further by considering interactions with other systems even if they are not being served directly. It is likely that potentially foreseeable problems and issues related to interactions with other work systems will be overlooked or downplayed if systems analysis and design assumes that the goal is to build a computer-based artifact that is used by users and that the requirements are basically a detailed specification of that computer-based artifact. Most current analysis and design books and journal articles in the IS field seem to take that position by focusing primarily on detailed documentation of processes, information, and technology within individual systems, with special emphasis on the processing of computerized information. While not belittling the obvious importance of guidance and methods related to gathering, representing, visualizing, and documenting requirements, this paper explores a direction in which systems analysis and design in the IS field might provide additional value.

Describing and analyzing interactions with other work systems calls for concepts, tools, and methods that are outside of today's mainstream systems analysis and design in the IS field. The many types of interactions between systems range from persistent interactions such as supplier-customer relationships through transient interactions related to mishaps. A thorough analysis should consider indirect impacts, such as effects of inconsistent goals, inconsistent standards, and inconsistent treatment of personnel. It also should consider direct and indirect impacts of inadequate performance of other work systems. Thus, it should encompass both individual systems in isolation and systems in the larger context of system interactions.

This paper's goal is to identify concepts and taxonomies for understanding, analyzing, and designing interactions between IT-reliant work systems. Its discussion of co-existence, alignment, and coordination of work systems is step toward a taxonomy of system interactions of types that are not covered well in typical systems analysis and design. Given the frequent occurrence of system conflicts and inefficient system interactions, development of tools and methods based on those ideas could be valuable to system developers, managers, and researchers. Existing theory (e.g., the three types of task interdependence (Thompson, 1967), coordination theory (Malone et al, 1999; Crowston et al, 2006), and loose coupling theory (Orton and Weick, 1990) does not cover that scope in a direct and complete manner.

The next section identifies some of the concepts that should be included in tools and methods for understanding and analyzing system interactions. The two subsequent sections identify different types of system interactions and provide examples of persistent and transient interactions related to each element of the work system framework. Further development of these ideas could lead to a theory of system interactions, new tools and methods for systems analysts and designers, and propositions that could be tested empirically.

MAJOR CONCEPTS

The first step toward a taxonomy of system interactions is to identify some of the main concepts that are relevant, such as:

- **System interactions** are situations and events in which the existence, design, operation, inputs, and/or outputs of one work system affect another work system. System interactions may be uni-directional or mutual, and may involve specific work system elements, groups of elements, or work systems as a whole.
- **Intentionality** of interactions describes the extent to which interactions between two work systems are intentional. This continuous dimension goes from unintentional to intentional.
- **Directness** of interactions describes the extent to which interactions between two work systems are direct. This continuous dimension goes from indirect to direct.
- **Explicitness** of interactions describes the extent to which interactions between two work systems are explicit. This continuous dimension goes from implicit to explicit interactions.
- **Persistence** of interactions describes the extent to which interactions between two work systems persist over time. This continuous dimension goes from transient to persistent. Although transient interactions may occur rarely or occasionally, they may have major consequences.
- **Alignment** describes the extent to which two work systems are aligned. Interacting work systems A and B are more highly aligned if their primary goals are more highly aligned with the goals of work system C, which is a superset of both or which both of them serve. For example, if customer satisfaction is the primary goal for A, B, and C, then they are more aligned than if A's primary goal is internal productivity and B's primary goal is customer satisfaction.
- **Congruence** of work systems A and B is a continuous variable summarizing similarity of form, logic, and details in corresponding elements of A and B. For example, using consistent information or interoperable technology implies that two work systems are more congruent than if their information is inconsistent or their technology is not interoperable. Congruence between A and B typically facilitates their interactions, but is not necessary if they serve very different roles within mutual supersystem C.

TYPES OF INTERACTIONS

Table 1 identifies different types of system interactions between system A and system B. Some types of interaction are intentional, while other types are usually unintentional. The sequence of interaction types is organized from the highest to the lowest degree of control that A exerts over B. Table 1 start with categories related to coordination and control, and moves toward categories related to alignment and co-existence. Each type of interaction will be explained briefly. A more thorough explanation would include more examples and would explain the extent to which current systems analysis tools and methods handle each type of interaction gracefully.

Table 1: Different types of interactions between two work systems

General category	***Common types of interaction***
Direct control	• System A initiates system B • System A authorizes system B
Joint control	• Negotiated resource sharing: A and B negotiate about how resource X is to be shared • Negotiated supply of a resource: A and B negotiate about the details of resource X that A will produce for B
Precedence-based control	• The initiation, status, or completion of work in system A directly impacts the initiation, status, or completion of work in B whether or not the impacts are intended. An example is unnegotiated resource sharing in which systems A and B both use resource X, which either may seize on a first-come, first-served basis.
Management oversight	• System A manages or monitors system B but does not control or participate directly in its operations.
Auditing control	• System A, which does not manage system B, audits system B to make sure that system B conforms to externally imposed rules and standards.
Malicious aggression	• System A purposefully attempts to disrupt, sabotage, and/or steal from system B.
Inadvertent interactions	• The alignment or misalignment of systems A and B have an impact on system B. • The congruence or noncongruence of systems A and B have an impact on system B. • Unnegotiated resource sharing affects system B when A seizes a required resource.
Accidental interactions	• Malfunctions or delays in system A affect the performance of system B.
Implicit interactions	• Evaluation, analysis, and/or design processes related to system A reveal issues that eventually affect the form, function, or logic of system B.

Direct control. System A initiates or authorizes specific actions within system B. A controls aspects of B’s operation because B cannot proceed until A provides the initiation or authorization, as happens when an air traffic controller gives instructions to a pilot (thereby controlling the pilot’s work system) or when a government inspection process determines whether a construction project can proceed because it satisfies building codes. Workflow systems for reimbursements and other highly structured processes are often designed around this type of control.

The U.S. medical system illustrates common difficulties of direct control. Assume that system A is the insurance provider’s work system for authorizing expensive non-emergency medical procedures; B is a work system of providing medical care, including procedures and pharmaceuticals that are controversial or that the insurance provider wants to ration. Aside from being frustrating and time consuming, system interactions between A and B sometimes lead to worse medical outcomes or unnecessary expenses. For example, physicians whose prescriptions are limited by rules of an insurance plan sometimes “upcode” a diagnosis to make it severe enough to qualify for the desired course of treatment (e.g., Derby et al (2001), Pitches et al (2003)).

Joint control. A and B negotiate or at least provide inputs that control use of resource X or operation of work system B. Pooled and reciprocal interdependence in Thompson’s (1967) taxonomy would fall into this category. Coordination theory (Malone et al, 1999; Crowston et al, 2006) covers situations involving joint control, such as negotiated sharing of a resource and negotiated supply of a resource.

A key issue in evaluating joint control situations concerns the time and energy that goes into the negotiation instead of going into producing products and services for customers. If the negotiation is costly in time and energy, or if it sometimes generates unsatisfactory results, it may be desirable to structure or automate parts of the negotiation through some combination of simplification, standardized procedures, and business rules.

Design questions sometimes arise in joint control in situations involving special cases, exceptions, and error conditions. Assume that system A sells highly customized products and B is the planning system for manufacturing those products. In this joint control situation, allocation of capacity to a sale occurs only if system A requests it, and sales cannot finalize contract dates until B allocates the required manufacturing capacity. If B allocates capacity during a weekly meeting on Friday, contract finalization in system A will be delayed by several days on average. In unusual cases such as cancellation of the Friday meeting because of a snowstorm, B could cause even longer delays for A. More effective interaction might apply different approaches for typical situations and exceptional cases that require a workaround or special handling.

Precedence-based control. In precedence-based control, A's impact on B operates through precedence rather than through forms of direct control such as initiation or authorization. With precedence control, the initiation, status, or completion of A has a direct impact on the initiation, status, or completion of B even though no action within A considers or directs anything in B. Thompson's (1967) task interdependence taxonomy would call this sequential interdependence. Coordination theory would refer to this as a flow dependency. Internal value chains are a typical example. Someone needs to build the foundation of a new building before someone else can install the plumbing, but the system of building the foundation may ignore the system of installing plumbing. Precedence based control may not require that A complete before B starts. For example, the documentation and training production system (B) for an IS project might start after the software development (A) is well underway, but before all of the software details have been specified, programmed, or debugged.

Management oversight. System A manages or monitors system B but does not control its operations directly. Key design questions center on costs and effectiveness of management or monitoring methods. Common issues in management oversight range from problems of micromanagement to problems of ineffective, uninvolved management from afar. In analyzing interactions related to management oversight and monitoring one might ask whether more integration or less integration between A (the management or monitoring system) and B (the system managed or monitored) would yield better overall results, whether the information available to A provides sufficient insight about B, whether the rhythm of management interactions is helpful, and whether interpersonal or political issues between A and B cause conflicts.

Auditing control. The primary interests of system A, the auditor, are fundamentally different from the primary interests of system B, which is being audited or controlled. In these cases, the auditing entity may operate contrary to the short-term goals in B, such as boosting financial results. Many recent financial scandals have resulted from the inability or unwillingness of auditors and/or internal risk management groups to perform auditing control functions related to off-balance sheet liabilities, incorrectly priced assets, and excessive leverage. A different example of concern to software companies is auditing to determine whether sales transactions that were recognized in a particular quarter actually occurred in that quarter.

Malicious aggression. System A purposefully attempts to disrupt, sabotage, and/or steal from system B. Examples of malicious aggression range from industrial sabotage to computerized attacks by viruses and Trojan horses. In some cases, the malicious system (A) consists of people trying to infiltrate and disrupt a targeted work system through direct human action. In other cases, the malicious system is completely automated and operates through computer-to-computer interaction. Although a great deal of attention in the IS field goes to computer-related security, many security experts note that a large percentage of what are called computer security problems are actually problems related to carelessness by the participants in the targeted work system and inattention to basic security.

Inadvertent interactions. The abovementioned interactions all involve intentionality in operation or design. Except in the malicious case, the design of A and B incorporates authorization, negotiation, fulfillment of demand, monitoring, or some other designed interaction. In contrast, inadvertent interactions occur for no reason other than that A and B both exist and have some direct or indirect, uni-directional or mutual interaction. For example, a change in a sales organization's key salespeople may result in higher or lower output goals for manufacturing, which may then affect the operation of the HR department by requiring job changes to handle greater hiring needs or tasks related to layoffs. Greater alignment and/or congruence between two work systems should imply that inadvertent interactions tend to be more successful and inadvertent conflicts tend to be resolved more easily. The relevant aspects of alignment and congruence in these situations include shared culture, similar goals, shared terminology, similar expectations, and personnel practices.

Accidental interactions. These interactions occur when mishaps, breakdowns, or major positive or negative changes in the performance of system A have unanticipated impacts on system B. Accidental interactions are treated as separate from inadvertent interactions because many inadvertent interactions do not involve mishaps, breakdowns, or sudden changes in the performance of system A.

Implicit interactions. All of the above system interactions occur as two or more work systems operate simultaneously or as system A produces things that are needed by system B or that affect system B in other ways. In implicit interactions, the evaluation, analysis, and/or design processes related to system A reveal issues that eventually affect the form, function, or logic of system B. Implicit interactions include redundancies, overlaps, and interactions during work system life cycle (Alter, 2006; 2008a; 2008b) phases of initiation, development, and implementation.

TYPES OF PERSISTENT MISALIGNMENT AND NON-CONGRUENCE

Typical system interaction problems are related to goal conflicts, delays, lack of fit, inefficiency, confusion, and accidents. Overlaying the nine elements of the work system framework (Figure 1) upon the different types of work system interactions in Table 1 generates a way to organize common problems related to system interactions. Tables 2 and 3 provide examples of persistent and transient interactions, respectively.

Table 2 identifies different types of persistent misalignment and/or non-congruence between work systems as a whole and between corresponding elements of two work systems. Persistent misalignments and non-congruence are the result of design features in A and B and may or may not be related to direct dependencies. Each entry in Table 2 concerns potentially consequential interactions and impacts that might be missed in an analysis. This paper's length limitations prevent discussion of the many individual cases.

Table 3 identifies typical transient issues that affect specific work system elements (and the work system as a whole) due to problematic system interactions that occur occasionally or rarely. Transient issues sometimes result from persistent misalignments and/or non-congruences in Table 2 and sometimes result from errors, exceptions, and other unexpected events. Organizing transient problems and issues by work system element (rather than general category such as direct or joint control) fits well with a typical work system analysis approach which looks at each of the nine work system elements in turn to make sure that foreseeable problems, opportunities, and issues are not overlooked. Transient problems such as those in Table 3 can be incorporated into systems analysis and design using checklists or other tools to minimize the likelihood of ignoring or downplaying important system interactions that could affect work system performance.

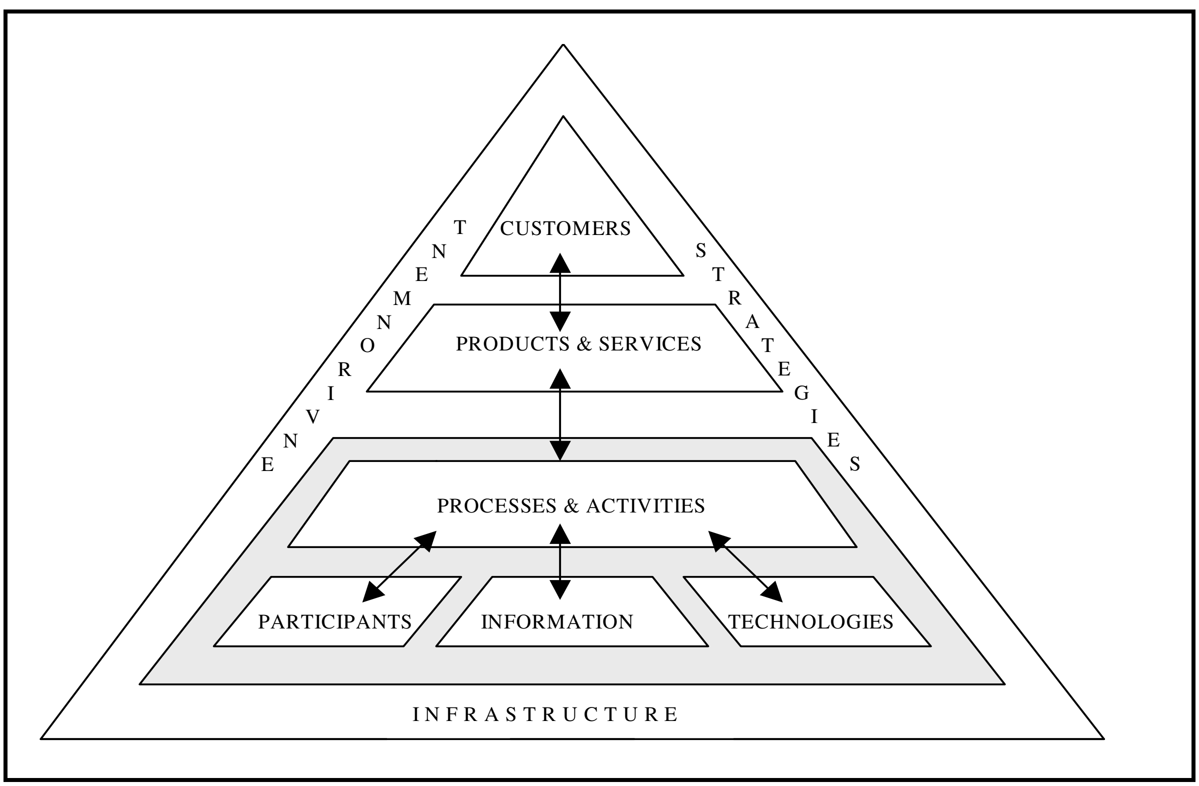

Figure 1. The Work System Framework (Alter, 2008a; 2008b)

Table 2. Types of persistent misalignment and non-congruence between corresponding work system elements within system interactions	
Work System Element	***Typical example of persistent misalignment or non-congruence of interacting work systems***
Work system as a whole	• Goal divergence: Conflicts in A and B's primary goals may interfere with their interactions and may affect the performance of supersystem C or system D that both A and/or B serve.
Customers	• Inconsistencies between customers' functional requirements for A's products and customers' functional requirements for B's products. • Inconsistencies between the customer's performance goals for A's products and the customer's performance goals for B's products (E.g., work system A's primary customers are concerned with cutting costs, while B's customers are concerned with maintaining an image of top quality.)
Products and Services	• A's products and services are not designed to fit B's needs.
Processes and Activities	• Operating at cross-purposes: B undoes some of what A does. • Operational interference: A's operation interferes with B's operation. • Inadequate synchronization: Shortcomings in methods for synchronizing A and B degrade the performance of A and/or B • Built-in delays: The design of the interaction between A and B generates delays. • Lack of fit: A's and B's work practices related to their interaction or the outcomes of their interaction fit poorly, resulting in inefficiency and confusion. • Inconsistencies in work practices of A and B cause morale problems. (e.g., Why do workers in A get to go home at 5:30 while those in B need to stay later?)
Participants	• Personal or organizational disputes and rivalries between people in A and people in B may be counterproductive or disruptive. • The same people participate in A and in B, and sometimes cannot perform all of their roles and responsibilities in both. • Participating in A affects a participant's error rate when working in B. • Participants in A cannot perform activities in B due to occurrences or activities in A.
Information	• Inconsistency between information used in A and in B causes problems. • Poorly designed information flow between A and B causes confusion, inefficiency, or delays. • B's operation tends to suffer due to lack of access to information about the status of A or of whatever it will receive from A. • Information used by A to manage B may be inconsistent with information available to participants in B.
Technology	• Technical inconsistencies between A and B cause extra work. (e.g., one uses Wintel PCs; the other uses Macs.) • A's technology is not interoperable with B's technology.
Environment	• Cultural inconsistencies between A and B. • Inconsistencies between A and B regarding enforcement of regulations and standards.
Infrastructure	• Inadequate methods for sharing of human, technical, or informational infrastructure negatively affect the performance of A and B.
Strategies	• A's strategy is inconsistent with B's strategy. • A and/or B's strategy is inconsistent with the strategy of the surrounding organization.

Table 3. Transient operational problems or issues related to system interactions

Work System Element	***Typical problem or issue***
Work system as a whole	• Goal divergence between A and B causes instances of inefficiency or delays. • Errors, exceptions, or other events in A cause instances of inefficiency or delays in B. • Transient problems in A cause B to shut down. • Transient problems in A cause diversion of resources from B to A. • Lack of synchronization between A and B causes instances of delays and inefficiencies.
Customers	• Delays, fit issues, or other problems in A decrease the satisfaction of B's customers. • Unanticipated disagreement between customer requirements for A and customer requirements for B causes problems.
Products and Services	• B's products and services are delayed because of difficulties with system interactions. • Unanticipated inconsistencies between products of A and of B cause problems.
Processes and Activities	• Errors, exceptions, or aspects of A's processes and activities cause inefficiency or delays in B. • Lack of synchronization between A and B causes instances of overload in B. • Ineffective resource sharing between A and B causes inefficiency or delays in B. • Processes and activities in A sometimes interfere with processes and activities in B. • Multitasking between A and B sometimes causes inefficiencies or errors. • B sometimes needs to devote excess time to dealing with system A and resource X, or possibly X's substitutes. • Processes and activities in B suffer when they don't take into account possible delays due to A. • Management work done by A diverts time and energy from doing work in B.
Participants	• Personal or organizational disputes and rivalries between people in A and people in B flare up and affect performance negatively. • People who participate in both work system A and work system B sometimes become inefficient or overworked due to multiple demands.
Information	• Errors or exceptions in the information flow between A and B cause confusion or delays. • Inconsistency between information used in A and in B causes transient problems. • A is sometimes unaware of what B needs. • B is sometimes unaware of what A is providing. • B's lack of access to information about A causes errors or inefficiency. • Inconsistency between information in B and information used by A to manage B sometimes causes wasted time and effort.
Technology	• Technical failure in A causes extra work or delays in B.
Environment	• Cultural inconsistencies between A and B flare up as problems in their interaction. • Inconsistencies between A and B regarding enforcement of regulations and standards cause operational problems for B.
Infrastructure	• Failures or problems in human, technical, or informational infrastructure negatively affects interactions between A and B.
Strategies	• Strategy inconsistencies between A and B or between A, B, and the surrounding organization cause counterproductive interactions, inefficiency, or other problems.

POSSIBLE PROPOSITIONS RELATED TO WORK SYSTEM INTERACTIONS

In addition to helping with the classification of system interactions, the concepts mentioned thus far form the basis of propositions that can be tested empirically:

P1: Greater attention to co-existence, alignment, and coordination of work systems in organizations leads to greater success of system projects.

P2: Greater alignment between work systems increases the effectiveness and efficiency of designed interactions between them.

P3: Greater alignment between work systems decreases the difficulty of resolving the effects of unplanned or accidental interactions that are viewed as problems.

P4: Greater congruence between work systems decreases the difficulty of resolving the effects of unplanned or accidental interactions that are viewed as problems.

Quantitative measures of the congruence between work systems can be constructed by creating scaled estimates about the extent to which their corresponding elements have similar goals, form, logic, and details, and then combining those estimates. In practice, the key issue is not about statistical evaluation, but rather about identifying and correcting areas of misalignment and non-congruence that might cause problems and therefore might be worth ameliorating.

CONCLUSION

This paper identified many situations illustrating why co-existence, alignment, and coordination of work systems deserve more attention in systems analysis and design. Specific topics included:

Categories of system interaction beyond those in coordination theory. Table 1 summarized a taxonomy of system interactions organized based on the degree of control of one system over another. Some categories in Table 1 overlap with coordination theory (e.g., joint control and precedence-based control), while other categories related to inadvertent, accidental, and implicit interactions identify additional types of interactions that often affect the performance of IT-reliant work systems.

Misalignment and non-congruence between work systems. Table 2 summarized new and potentially valuable way to think about alignment in the IS field by using work system elements to organize a list of persistent misalignments and non-congruences between interacting work systems. The term alignment had been used mainly in relation to IT-business alignment at the executive level. (e.g., Reich and Benbasat, 2000; Luftman et al, 2006). An expanded version of Table 2 could be a valuable tool for analyzing or evaluating interactions between work systems within and across organizations.

Persistent and transient interactions of IT-reliant work systems. Table 3 contributes to systems analysis and design by identifying transient problems or issues related to system interactions that arise occasionally when a mishap occurs or when one of the systems operates outside of its usual range. Some transient problems are addressed by coordination theory or by other ideas in the literature related to mutual adjustment and articulation (e.g., Schmidt and Simone, 1996) or workarounds (e.g., Strong and Miller, 1995). Although ideas about coordination, articulation, and workarounds are useful, many transient problems are more related to accidental interference between systems and vulnerability to security threats.

Opportunities for Future Development of These Ideas

This paper introduced and organized a series of topics related to system co-existence, alignment, and coordination that could enrich systems analysis and design and should be incorporated into appropriate tools and methods. A substantially longer paper would have developed the ideas more completely. It would have discussed the limits of prior literature involving general systems theory, organization theory, coordination theory and loose coupling theory. It would have discussed other categories that could not be included, including different types of implicit interactions such as redundancy, overlap, and conflicts surfaced during system development. It might have explained how to test the four propositions that it proposed. It might have presented a preliminary list of design patterns (e.g., Gamma et al, 1995) and might have linked those design patterns to specific types of system interactions.

Further development of the ideas in this paper could be valuable in a number of areas. It could lead to a theory of system interactions. It could generate tools and methods for systems analysts and designers, e.g., computerized questionnaires or other tools for identifying important or problematic interactions for a system that is being built or improved. An extended version of the propositions could lead to empirical research related to the relative importance of different risk factors. Ideally, future research will extend this paper's ideas in those directions.

REFERENCES

1. Ackoff, R.L. (1994) *The Democratic Corporation: A Radical Prescription for Recreating Corporate America and Rediscovering Success*, Oxford University Press, Oxford, UK.
2. Alter, S. (2006) *The Work System Method: Connecting People, Processes, and IT for Business Results*, Work System Press, Larkspur, CA.
3. Alter, S. (2008a) "Defining information systems as work systems: implications for the IS field." *European Journal of Information Systems*, 17, 5, 448-469.
4. Alter, S. (2008b) "Service System Fundamentals: Work system, value chain, life cycle," *IBM Systems Journal*, 47, 1, 71-85.
5. Checkland, P. (1999) *Systems Thinking, Systems Practice*, John Wiley, Chichester, UK.
6. Crowston, K., J. Howison, J. and Rubleske, J. (2006) "Coordination Theory: A Ten Year Retrospective," in P. Zhang and D. Galletta, D. (eds.) *Human-Computer Interaction in Management Information Systems* – Foundations, M. E. Sharpe, Inc., Armonk, NY.
7. Derby, C. A. et al. (2001) "Possible effect of DRGs on the classification of stroke subtypes: Implications for surveillance." *Stroke*, 32, 1487-1491.
8. Gamma, E., Helm, R. Johnson, R and Vlissides, J. (1995) *Design Patterns: Elements of Reusable Object-Oriented Software*. Addison-Wesley, Reading, MA.
9. Luftman, J., Kempaiah, R., and Nash, E. (2006) "Key Issues for IT Executives 2005," *MIS Quarterly Executive*, 5, 2, 27-45.
10. Malone, T. W., et al. (1999) "Tools for inventing organizations: Toward a handbook of organizational processes," *Management Science*, 45, 3, 425-443.
11. Orton, J.D. and Weick, K.E. (1990) "Loosely Coupled Systems: A Reconceptualization," *The Academy of Management Review,* 15, 2, 203-223.
12. Pitches, D., Burls, A. and Fry-Smith, A. (2003) "How to make a silk purse from a sow's ear--a comprehensive review of strategies to optimise data for corrupt managers and incompetent clinicians," *British Medical Journal*, 327, 1436-1439.
13. Reich, B.H. and Benbasat, I. (2000) "Factors that Influence the Social Dimension of Alignment between Business and Information Technology Objectives," *MIS Quarterly*, 24, 1, 81-113.
14. Schmidt, K., and Simone, C. (1996) "Coordination mechanisms: Towards a conceptual foundation of CSCW systems design." *Computer Supported Cooperative Work: The Journal of Collaborative Computing*, 5, 155–200.
15. Skyttner, L. *General Systems Theory*, Singapore: World Scientific Publishing, 2001.
16. Strong, D. M. and Miller, S. M. (1995) "Exceptions and Exception Handling in Computerized Information Processes," *ACM Transactions on Information Systems*, 13, 2, 206-233.
17. Thompson, J.D. (1967) *Organization in Action*, Mc Graw- Hill, Chicago, IL.