

Association for Information Systems AIS Electronic Library (AISeL)

ICIS 2008 Proceedings

International Conference on Information Systems
(ICIS)

2008

Validating the Information Systems Design Theory for Dual Information Systems

Timo Käkölä

University of Jyväskylä, timokk@jyu.fi

Andreas Taalas

Accenture, andres.taalas@accenture.com

Follow this and additional works at: <http://aisel.aisnet.org/icis2008>

Recommended Citation

Käkölä, Timo and Taalas, Andreas, "Validating the Information Systems Design Theory for Dual Information Systems" (2008). *ICIS 2008 Proceedings*. 119.

<http://aisel.aisnet.org/icis2008/119>

This material is brought to you by the International Conference on Information Systems (ICIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in ICIS 2008 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

Validating the Information Systems Design Theory for Dual Information Systems / Validation de la Théorie de Conception de Systèmes d'Information pour les Systèmes d'Information Duels

Journal:	<i>International Conference on Information Systems 2008</i>
Manuscript ID:	ICIS-0798-2008.R1
Track:	Design Theory and Research
Keywords:	Business process management, Change management, Collaboration technology, Computer literacy, Design/design science, Enterprise resource planning, Groupware, Information system development, IS maintenance, IT alignment
Abstract:	<p>Conceptual designs of most information systems (IS) reflect a design/use dualism of technology making it difficult for users to be responsible for computerized aspects of work. The IS design theory (ISDT) for Dual Information Systems (DIS) helps bridge the design/use dualism. Its validity has not been studied empirically. This paper presents and applies a model that helps examine the validity of the ISDT. A domain-specific ISDT for Dual Change Management IS (DCMIS) is designed and applied to evaluate a change management IS (CMIS) in an organization responsible for managing a globally deployed enterprise resource planning system. The ISDT for DIS is found applicable for designing the ISDT for DCMIS, showing that IS theory development can be based on paradigms endogenous to the field. The ISDT for DCMIS can be utilized to solve problems in the use of the CMIS. It makes the ISDT for DIS increasingly tractable for practical applications.</p> <p>Résumé Les systèmes d'information (SI) cachent souvent des principes économiques complexes le rendant difficile pour que les utilisateurs soient responsables des aspects computerized de travail. La théorie de SI de conception (SIDT) pour les systèmes d'information duels de conception d'aides de systèmes d'information de sorte que les utilisateurs puissent être responsables de leur travail. Ce document présente et applique un modèle générique de recherches à l'examine la validité de l'SIDT dans une organisation contrôlant un système globalement déployé de planification de ressource d'entreprise.</p>

VALIDATING THE INFORMATION SYSTEMS DESIGN THEORY FOR DUAL INFORMATION SYSTEMS

Validation de la Théorie de Conception de Systèmes d'Information pour les Systèmes d'Information Duels

Completed Research Paper

Timo Käkölä

Claremont Graduate University &
University of Jyväskylä
40014 University of Jyväskylä, Finland
timokk@jyu.fi

Andreas Taalas

Accenture
00101 Helsinki, Finland
andreas.taalas@accenture.com

Abstract

Conceptual designs of most information systems (IS) reflect a design/use dualism of technology making it difficult for users to be responsible for computerized aspects of work. The IS design theory (ISDT) for Dual Information Systems (DIS) helps bridge the design/use dualism. Its validity has not been studied empirically. This paper presents and applies a model that helps examine the validity of the ISDT. A domain-specific ISDT for Dual Change Management IS (DCMIS) is designed and applied to evaluate a change management IS (CMIS) in an organization responsible for managing a globally deployed enterprise resource planning system. The ISDT for DIS is found applicable for designing the ISDT for DCMIS, showing that IS theory development can be based on paradigms endogenous to the field. The ISDT for DCMIS can be utilized to solve problems in the use of the CMIS. It makes the ISDT for DIS increasingly tractable for practical applications.

Keywords: Business process management, Change management, Collaboration technology, Computer literacy, Design/design science, Enterprise resource planning, Groupware, Information system development, IS maintenance, IT alignment

Résumé

Les systèmes d'information (SI) cachent souvent des principes économiques complexes le rendant difficile pour que les utilisateurs soient responsables des aspects computerized de travail. La théorie de SI de conception (SIDT) pour les systèmes d'information duels de conception d'aides de systèmes d'information de sorte que les utilisateurs puissent être responsables de leur travail. Ce document présente et applique un modèle générique de recherches à l'examine la validité de l'SIDT dans une organisation contrôlant un système globalement déployé de planification de ressource d'entreprise.

Introduction

Businesses need to align complex, integrated information systems (IS) with their business processes. For example, enterprise resource planning packages can be composed of thousands of components that become outdated quickly without systematic upgrades. Maintaining alignment is nontrivial partly because conceptual designs of IS often reflect a design/use dualism of technology: work-domain knowledge is nontransparently encoded in the software during system design, making it difficult for actors to be responsible for computerized aspects of work during system use. For example, software developers often work with overlapping and poorly integrated software tools which may optimize subprocesses such as requirements engineering but do not adequately support the understanding and coordination of end-to-end development processes over the application life-cycles (Käkölä et al. 2009).

Information system design theories (ISDT) should be created to design systems in a way that alleviates the design/use dualism. ISDTs are prescriptive theories having two aspects (Walls et al. 1991, 42): “one dealing with the product and one dealing with the process of design.” The process aspect is beyond the scope of this paper due to

space limitations. Walls et al (1991) define four components of the product aspect: *Meta-requirements* describe the class of goals to which the theory applies; *Meta-design* prescribes a class of artifacts hypothesized to meet the meta-requirements; *Kernel theories* from natural or social sciences and mathematics govern meta-requirements; *Testable design product hypotheses* are used to empirically test whether the meta-design satisfies the meta-requirements.

A domain-independent IS design theory for Dual Information Systems (DIS) helps actors bridge the design/use dualism and design end-to-end business processes and information systems together with middle management, information systems experts, and other stakeholders (Käkölä 1996a). Applications designed in accordance with the ISDT provide services that (1) conceptually unite manual and computerized aspects of work; (2) let actors zoom in on the details of work and check shared databases for mistakes to deepen their knowledge and handle exceptions locally; (3) help actors interact in redesign project teams where they can share best practices and crystallize them into process redesigns; and (4) store the design knowledge in the organizational knowledge base for later reuse.

The validity and utility of the ISDT for Dual Information Systems have not been studied empirically. Because the ISDT is domain-independent, it cannot be assessed directly using empirical research methods. Figure 1 presents the research model that helps researchers and designers examine the validity and utility of the ISDT by (1) applying domain knowledge and the ISDT for DIS to construct domain-specific ISDTs, (2) applying the domain-specific ISDTs to evaluate and redesign IS in case organizations, (3) analyzing the validity and utility of the domain-specific ISDTs, and (4) analyzing the significance and ease-of-use of the ISDT for DIS in constructing domain-specific ISDTs.

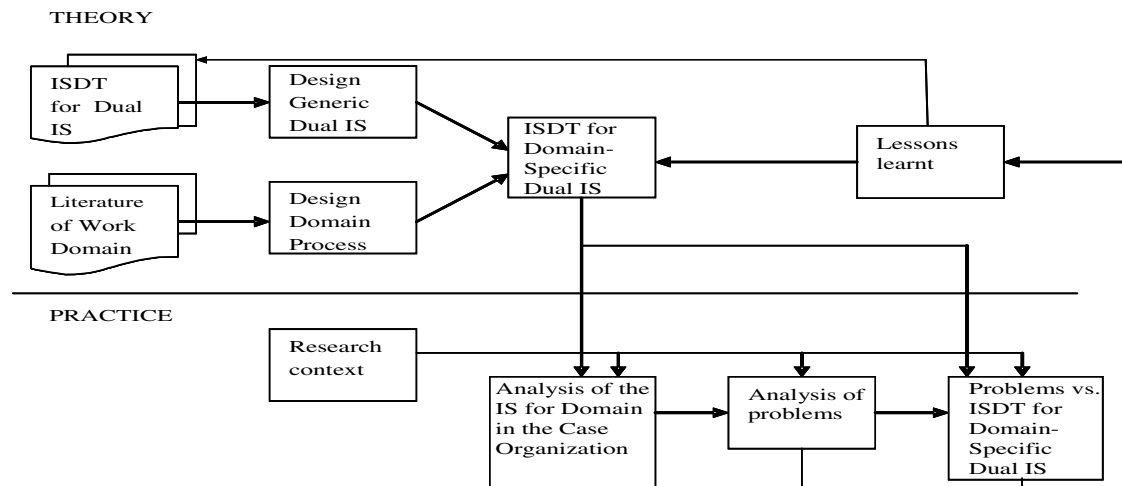


Figure 1. The Research Model

This paper applies the research model to initiate the empirical validation of the ISDT for DIS. First, a domain-specific ISDT for Dual Change Management IS (DCMIS) is designed by leveraging the ISDT for DIS and the literature about change management practices (CM) and organizations (CMOs). The ISDT for DCMIS addresses the following question: what are the necessary and sufficient properties for the class of change management information systems (CMIS) that enable CMOs to achieve their business goals? Second, the ISDT for DCMIS is applied in a case study to evaluate a CMIS in a CMO responsible for aligning an enterprise resource planning package (hereafter “organizational IS”) with the business processes of a global corporation. CMO uses CMIS to collect, evaluate, and prioritize the change requests of end-users and business management, allocate accepted requests to software vendors for implementation, receive software components, and coordinate their installation. Third, the problems CMO perceived with CMIS are assessed and the ISDT for DCMIS is deployed to explain and solve them.

The concept of change management resembles closely to ISO (2006, 3-4) definition for software maintenance which is the “modification of a software product after delivery” to correct discovered problems, to detect and correct latent faults before they become operational faults, and to keep a software product usable in a changing environment. However, the concept refers to the management, control, and coordination of maintenance efforts.

Change management is an excellent context for validating the ISDT for DIS. It is knowledge-intensive work involving substantial risks and geographically distributed partners. CMOs need to be active in process development because they are drivers of organizational change (Nance 1996; Truex et al. 1999). If a CMO cannot proactively develop itself, it can hardly keep up with managing the changes required in organizational IS. Actors in CMOs have information technology (IT) expertise that far exceeds the novice level of IT expertise assumed in the ISDT for DIS (Käkölä 1996a). They are responsible for changing the IS and thus experienced in organizational change. They

should understand the objects to be changed, work flows, and the CMO holistically to coordinate work, handle exceptions, manage risks, and improve processes effectively. The extant literature provides little theory-based guidance for designing CMIS. The ISDT for DIS supports IS development in such complex organizational contexts.

The case organization has neither applied the ISDT for DIS nor other theoretically grounded organizational and IS design methods to design their change management organization and information system. Based on the ISDT for DIS, their CMIS should thus have become institutionalized and hidden its constructed nature from actors due to the design/use dualism, thus falling short in helping the CMO to achieve its goals. Indeed, as the case study will show, the case organization has faced such problems and the ISDT for DCMIS can be utilized to explain and solve them.

The next section briefly explains the ISDT for DIS. Then the change management literature is reviewed and the preliminary ISDT for DCMIS is constructed. Section “Change Management Practices and Information Systems - Case Metso Paper” assesses the validity and utility of the ISDT for DCMIS and the ISDT for DIS. The paper concludes by discussing the theoretical and practical contributions and identifying issues for future research.

An Information Systems Design Theory for Dual Information Systems

This section first explores the key kernel theories of the ISDT for DIS: act-oriented perspective and the hypertext organization. Then it derives meta-requirements for the ISDT from the kernel theories and outlines the meta-design of the ISDT for DIS providing domain independent meta-requirements for the ISDT for Dual Change Management IS.

Kernel Theories and Meta-requirements of the ISDT for Dual Information Systems

Technologies are dual, that is, both constructed and institutionalized (Orlikowski 1992). Designers produce a technology by encoding work-domain knowledge into it. Actors socially construct a technology by assigning it meanings. Technologies become institutionalized over time because actors cannot continuously reinterpret or physically modify them if the actors are to accomplish their work efficiently (Eriksson et al. 1988; Orlikowski 1992; Zuboff 1988). This inflexibility results in part from actors with insufficient shared knowledge of: (1) the nature of social practices; (2) the articulation of the practices in time and space by the structural properties of organizations; (3) their own roles in the organization; and (4) the role of IS as a structural property mediating work.

A reason for actors' unawareness is that the conceptual and material structures of software typically reflect the *design/use-dualism* of technology; during the institutionalized use of an IS the constructed nature of the IS is often masked by the software. Masking occurs when the processing rules and retention structures are hidden in the software and the roles of people as the producers and consumers of information are blurred (Nurminen 1988).

The act-oriented perspective helps actors regain control of their work (Eriksson & Nurminen 1991; Nurminen 1988; Käkölä 1995; Käkölä & Koota 1999a). It states that IS cannot be separated from actors' work because no IS can serve as a conscious actor. Accordingly software modules should be designed so they can be interpreted as computerized tasks that have responsible human actors. It bridges the design-use dualism by seeing the knowledge encoded in software by designers in time-space context A as the acts of the responsible actors in time-space context B.

The ISDT for DIS meets the meta-requirements posed by the act-oriented perspective and provides actors with tools to understand holistically their work tasks and context, overcome breakdown situations, and enable ongoing development of work practices and supporting IS. The individual IS designed and integrated according to the meta-design of the ISDT for DIS and used in an organizational unit form the DIS of the unit (Käkölä 1996a).

The act-oriented perspective has two limitations. First, well-developed *local* understanding of work is necessary but insufficient for improving end-to-end processes. Second, the IS architecture needed to align IS with the act-oriented perspective may be expensive to build when numerous poorly integrated legacy systems prevail. For example, integrated IS often hide their constructed nature to the extent that they appear to actors as acting, knowledgeable subjects (Eriksson & Nurminen 1991). The redesign of these systems to reflect the act-oriented perspective would unlikely be attractive to organizations if the benefits were limited to understanding better “what is.”

The meta-design of the ISDT for DIS draws upon Nonaka's (1994) hypertext organization design to alleviate the limitations. Hypertext organization is a *dual* organizational structure coordinating the allocation of time, space, and resources so an organization can achieve high performance in routines *and* ensure long-term survival. The ISDT for DIS also facilitates effective routine work *and* redesign work. Hypertext organization is comprised of knowledge-base, business-system, and project-system layers. The knowledge-base layer embraces tacit knowledge, associated with organizational culture and procedures, and explicit knowledge in the form of computerized databases, etc. (Nonaka 1994, 33). Work routines are enacted in the business-system layer. The project-system layer provides a field of interaction where project teams create knowledge. Knowledge is also created through the circular movement of

actors among the layers. Members of project teams are selected from the business-system layer. They interact with the knowledge-base layer and make an inventory of the knowledge created in the project-system layer.

Hypertext organization design prescribes the following meta-requirements (Käkölä, 1996a): Dual IS need to help actors join project teams to share knowledge of their work processes within and between organizational units; crystallize it into work systems and information systems (Alter 2006) that exceed expectations of customers, realize the visions of top management, and create good jobs; and network the knowledge (Nonaka 1994, 27) through the knowledge-base and business-system layers so it can be effectively applied across organizational levels and boundaries.

The Meta-design of the ISDT for Dual Information Systems

In accordance with the hypertext organization design, the meta-design of the ISDT for Dual Information Systems has three layers (Figure 2). Actors on the business-system layer draw on services of *the business-system layer of Dual Information Systems* to learn, enact, and coordinate activities, to zoom in on the details of their work, and to deepen their understanding of the computerized aspects of work in order to handle unexpected (coordination) breakdowns. Self-organizing project teams on the project-system layer use services of *the project-system layer and the knowledge-base layer (KBL) of DIS* to produce innovative work and IS (re)designs that can be enacted on the business-system layer. *The knowledge-base layer of Dual Information Systems* is a repository of explicit work and IS design knowledge in the knowledge-base layer of a hypertext organization. Due to space limitations, we detail the services in the sections describing the meta-design of the ISDT for Dual Change Management IS.

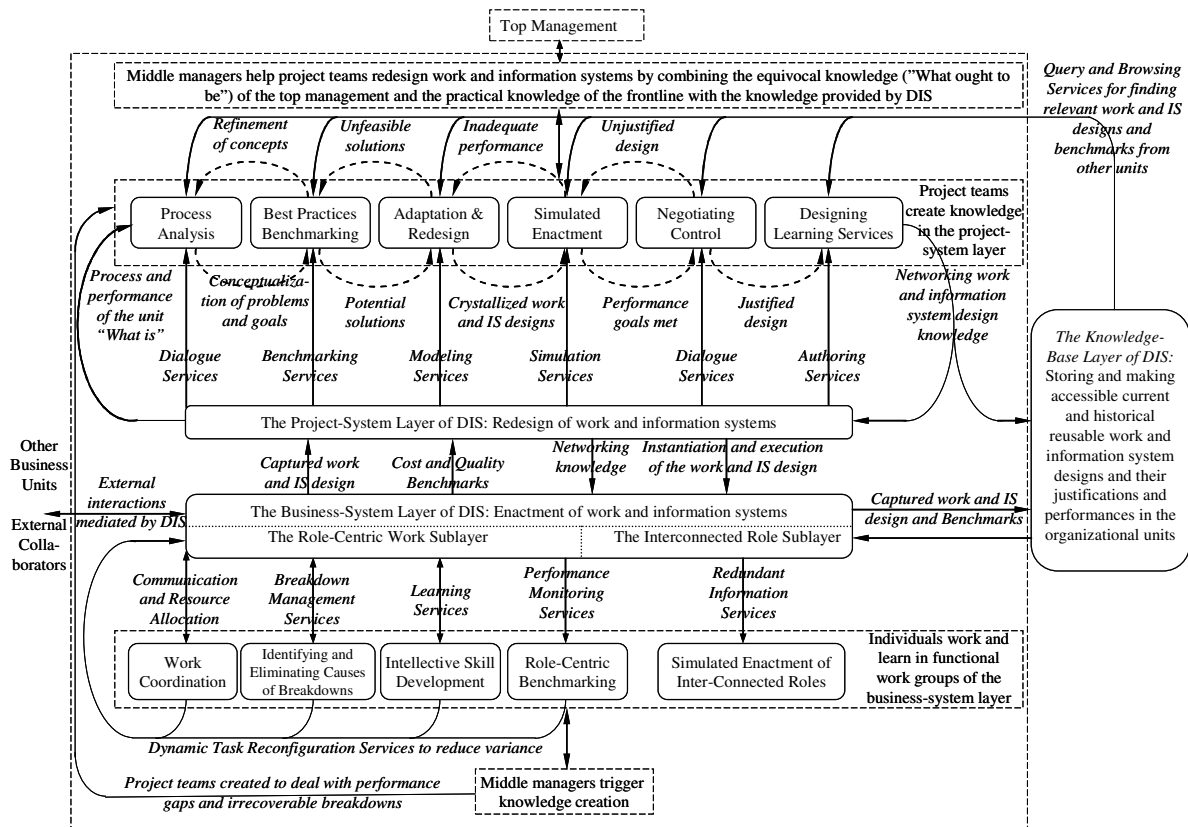


Figure 2. The Meta-Design of the ISDT for Dual Information Systems (revised from Käkölä 1996a, 79)

Concepts, Objectives, Processes, and Risks of Change Management

The concept of change management refers to the management, control, and coordination of maintenance efforts where interdependent actors process interdependent changes concurrently and iteratively (Davis & Sitaram 1994; Henry & Cain 1997; Joeris 1997b; Malone & Crowston 1994). The concept and associated theories of software maintenance define the software engineering activities for changing IS in production use (ISO 2006; Pressman 2005). It aims at maintaining an alignment between the IS and organization(s) by identifying change needs and institutionalizing procedures to incorporate the changes without endangering usability or maintainability. Changes

must be made by using appropriate planning, testing, and quality assurance methods (ISO 2006; Pressman 2005, Ch. 27). Knowledge of the changes made must be shared to all associated actors and preserved for future use (Pressman 2005), requiring well-defined procedures and communication and documentation practices (Joeris 1997a).

There are four types of changes: corrective, preventive, adaptive, and perfective (ISO 2006). The corrective activities consist of diagnosing and correcting the errors detected. The preventive activities proactively detect and correct latent errors before they turn into operational ones. The adaptive activities are associated with 'bending' the system to correspond to changing needs. Perfective activities enhance the IS by introducing new functionality (Swanson 1976, 1999). The corrective and preventive activities and the adaptive and perfective activities are combined, respectively, under the concepts of corrective maintenance and enhanceive maintenance (ISO 2006).

Change Management Process

The CM process model (Figure 3) divides sub-processes into technical and managerial process categories and into requirements validation (i.e., front-end) and release (i.e., back-end) phases (c.f., ISO 2005; Stark & Oman 1997).

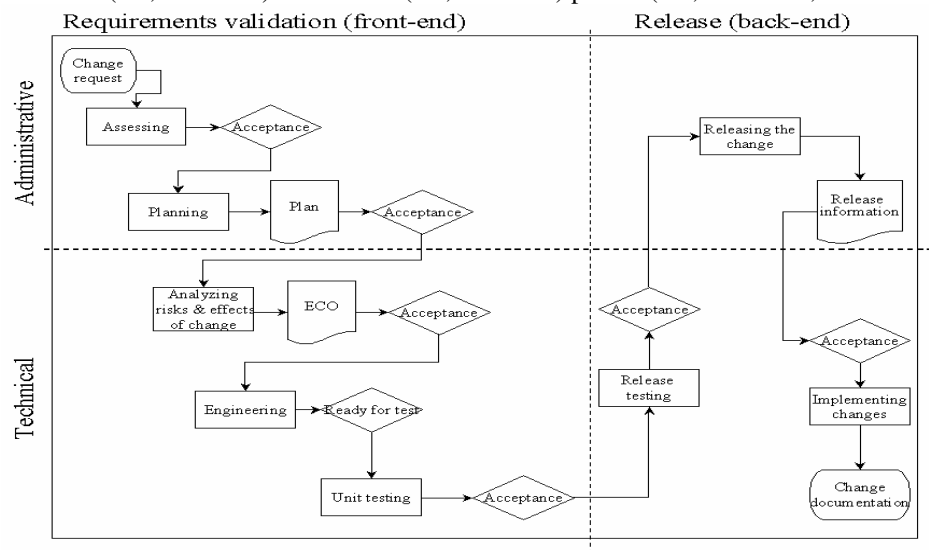


Figure 3. Change Management Process (adapted from Heikkilä 1999, 13; Joeris 1997a)

The Front-end of Change Management

The process begins with a change need arising from any stakeholder (Stark & Oman 1997). The reporting of needs must be easy for stakeholders. Otherwise, actors are likely to use workarounds to circumvent the problems, hampering the overall usability of the system (Gasser 1986). The need has to be externalized into an explicit change request document (CRD) (Pressman 2005, Ch. 27) that clarifies which part of the system should be changed, which changes are needed, and why. The requests must be stored to know in the future not only what changes have been made but also the reasons behind them (ISO 2005; Parnas & Clements 1986).

A corrective request can be a simple report describing the problem and the necessary actions to reproduce it. An enhanceive request can vary from simple task explanations (e.g., add a new data field) to requirements specifications (Salo & Käkölä 2005). Enhanceive requests and their implications must be discussed with all affected actors.

The needs must be assessed according to their priorities and target system areas because backlogs of unfulfilled needs typically emerge (ISO 2005; Sherer 1997; Stark & Oman 1997). The importance and urgency of a need must be compared to the effects the change would have to the system. The target areas of changes are used to group requests into development projects and identify overlapping and contradictory requests (Sommerville 2006, Ch. 21).

An engineering change order (ECO) is produced to detail the actions, responsibilities, and schedules for carrying out the changes (Pressman 2005, Ch. 27). Good knowledge of the IS is needed to define the components and system versions affected by the change. The sub-processes beginning from collecting requests and continuing until the engineering change order is ready constitute the analysis phase. A change control authority (CCA) makes the final go/no go decision (Pressman 2005). Software engineering tasks for realizing and testing the changes are not described here.

The Back-end of Change Management

This phase involves release testing of the solution to a certain need in a real system environment and releasing the components and documents needed to implement the solution in appropriate system configurations (Sommerville 2006, Ch. 29). Releases usually group changes into larger batches (Käkölä et al. 2009; Sherer 1997; Stark & Oman 1997). Component testing during development is necessary but the persons who will be using the system should test all system configurations using the new components (Haikala & Märijärvi 2006; Pressman 2005, Ch. 27). In release testing, the fulfillment of the original need and the problems associated with incompatibility of a solution with system environments are assessed. Changes are released to the environments in which they are applicable. The release should include the new or changed components and the changes in documentation. The implemented changes are documented to ensure their traceability (Käkölä et al. 2009; Sommerville 2006, Ch. 29).

Actors in Change Management

In accordance with the ISDT for DIS, each actor belongs to one or more groups with specific functional roles (Käkölä & Koota 1999a). *Initiators* are end-users, designers or other stakeholders interested in changing the system. They should follow the actions taken in response to their requests and test the changes made. *Analysts* collect and prioritize the requests and analyze the changes required. *Change control authority* makes the go/no go decision and the release decision after the proposed changes are ready to be implemented (Pressman 2005). *Engineering group* is responsible for development and preliminary testing. *Version owners* perform the post-release implementation of the change and release testing (Sommerville 2006, Ch. 29) for their versions. In the context of large IS, a group of *coordinators* mediates in problem situations, negotiates with change initiators, analysts, and the engineering group when system requirements are defined, and controls engineering and documentation of the process (Pressman 2005).

Risks in Change Management

Change management is characterized by the complexity of both the product (to be changed) and the process (Joeris 1997a). Complexity has been magnified with the increasing popularity of packaged enterprise software products and outsourcing (Ross et al. 2006; Käkölä 2008), increasing project risks, usability risks, and maintainability risks (Sherer, 1997). *Project risks* can be reduced by improving the coordination of sub-processes (Kraul & Streeter 1995) and the motivation and competencies of personnel (Sherer 1997). *Usability risks* materialize when the IS fails to respond to user needs related to, for example, functions, performance, or understandability of the IS (Sherer 1997). They can originate from unsuccessful specification of requirements associated with needs or poor construction and testing. *Maintainability* refers to the ease with which maintenance can be accomplished (Swanson 1999, 164; Sherer 1997). Extensive planning and documentation of changes made to different system components improve traceability, facilitate communication among stakeholders, and reduce *maintainability risks*.

An Information Systems Design Theory for Dual Change Management IS

The goal of a change management organization is to keep the organizational IS functional and aligned with the organizational needs. Change management IS should be used to minimize the risks in change management and achieve the goal effectively (Heikkilä 1999; Beresoff & Davis 1991; Hipkin 1996). This section first presents the domain specific meta-requirements and then elaborates on the components of the meta-design and the design product hypotheses of the ISDT for Dual Change Management IS. The services of the ISDT for DIS and their operationalization in the ISDT for DCMIS are summarized in Table 2.

Domain Specific Meta-requirements for the ISDT for Dual Change Management IS

The domain specific meta-requirements deal with the services of the business-system and knowledge-base layers. The services of the project-system layer of the ISDT for DIS are relatively domain independent. Dual CMIS artifacts following the ISDT for DCMIS support all CM subprocesses. The sharing and control of information becomes increasingly important as the number of actors increases (Beresoff & Davis 1991; Hipkin 1996). Backward and forward traceability of requests and changes are essential (Beresoff & Davis 1991). Electronic communications, concurrency control, and automation of complex but stable tasks promote coordination. The coordination oriented CMIS and the IS supporting technically oriented management and modeling of IS versions must be integrated (Joeris 1997a).

The DCMIS instance provides the CMO with “a means by which knowledge from the past is brought to bear on present activities, thus resulting in increased levels of effectiveness for the organization” (Stein and Zwass 1995,

89). It should automate the communication and control of information by establishing role-based workflows to ensure that the right information reaches the right persons at the right time (Salo & Käkölä 2005; Pressman 2005; Beresoff & Davis 1991), be easy to use and accessible to all actors, offer extensive search engines and reporting tools for both standard and ad hoc querying, and make transparent the actions taken (Beresoff & Davis 1991).

The Meta-design and Product Hypotheses of the Business-system Layer of the ISDT for Dual CMIS

The business-system layer supporting end-to-end change management is divided into role-centric work and inter-connected role layers. Actors work in a ‘common information space’ (Schmidt & Bannon 1992) on CRDs and other objects. Information related to CRDs is stored cumulatively in the KBL (Figure 4) (Sommerville 2006, Ch. 29). Querying functions help answer common (e.g., in which configurations of the IS the changes related to a certain CRD have been installed) and ad hoc questions (e.g., are there other CRDs related to the same system area as this one).

	CRD creation	Analysis	Implementation decision	Engineering	Testing	Release and implementation
Required information outputs	Need description (target area, functions etc.)	Implications of change Implementation proposal / plan	Grounds for decision Verified plan of implementation	Plans, documents and schedules of engineering. Change components	Testing memos and results	Information on implementation in different environments and user feedback
Responsible actor(s)	Change initiator	Analyst	CCA	Engineering group	Engineering group, change initiator	Version owners, IS users
Inputs in all stages	All actions taken regarding to the change and CRD, including dates and performers of actions. Urgency (priority) of the change and indicator of the phase of the CRD in the CM process. List of persons associated with the change to enable automated communication and support informal communication.					

Figure 4. Information Stored in the Knowledge-base Layer in Different Phases of Change Management

Role-centric Work Layer

The services of the role-centric work layer help actors in functional roles understand the constructed nature of information systems and take responsibility for their work (Käkölä 1996a).

Communication and resource allocation services

These services facilitate both formal and informal interaction because the complexity associated with change management requires communication within and across organizational boundaries (Kraul & Streeter 1995). The formal communication includes the delivery of CRDs and changes in them to all appropriate persons. The layer offers automated messaging functions such as the utilization of e-mail recipient lists. Electronic bulletin boards and discussion databases are preferable for informal communication as they make knowledge and discussions visible for all actors.

Resource allocation is closely tied to the functional role of a person (Salo & Käkölä 2005) and should be done centrally so the allocations (e.g., user rights) associated with both the layer and the organizational IS can be synchronized. This helps resource reallocation as the roles and groups in which people work frequently change (Mandiwalla & Olfman 1994).

Breakdown management services

The complexity of change management results inevitably in breakdowns in routines (c.f., Heidegger 1977). Breakdown management services collect information on common breakdowns in the knowledge-base layer. Because breakdowns may occur when actors misunderstand the computerized aspects of work, the services also let actors follow the proceeding of the most complex algorithms used in the layer and cancel actions after they have been committed (Käkölä 1995). The services and the improved understanding of work practices and good communication facilities provided by other services of the layer help prevent breakdowns and recover from them. The determination of the causes of breakdowns is facilitated by the traceability of actions provided by the layer. As the breakdowns cannot always be solved without experts, the expertise can be tracked, for example, by including the competence areas of actors in the knowledge-base layer (Davenport et al. 1998; Käkölä & Koota 1999a, Salo & Käkölä 2005).

Learning services

Learning services help actors learn intellectual skills (Zuboff 1988) facilitating the interpretation and communication of meaning in computer-mediated work environments. Zuboff (1988, 59) distinguishes these from “action-centered” skills that become inadequate when new symbolic language is introduced. Action-centered skills are learned through

bodily actions. The theoretical understanding of actions and their outcomes develops almost automatically because actors can see and feel the outcomes (Zuboff 1988, 187). When this shared action context is augmented or removed by IS, “meaning must be constructed explicitly in order to become implicit later” (Zuboff 1988, 192).

To transcend the design-use dualism, learning services make the learning of intellectual skills as easy as is the learning of action-centered skills. They promote holistic understanding of manual and computerized tasks through training materials visualizing the roles, tasks belonging to these roles, and the IS functions used to carry out the tasks (Käkölä 1995). The IS functions, that is, computerized tasks are embedded in the learning services. In this way, actors are offered the most relevant materials and support functions proactively by the system on a just-in-time basis. Learning services can be implemented quite easily. Process models, task lists, narratives, or other materials are needed due to the complex and risky nature of CM. Using lightweight techniques such as contextual help in data fields and action buttons ensures the transparency of the layer when complex algorithms are not involved.

Performance monitoring services

Performance monitoring services collect information to support the assessment of work arrangements. It can be collected in the form of quantitative indicators to assess the overall process performance and contrast it with the performance associated with actors (Pressman 2005, Ch. 22). The individual level information should be available for the actors, so they can get feedback on their actions regarding to company standards and goals. The services also give the management of the CMO performance information. However, to ensure adequate autonomy of actors, this information should focus on work results rather than on precise measurement of tasks (Käkölä 1996a).

There are four types of process performance indicators in CM (c.f., Haikala & Märijärvi 2006; Pressman 2005, Ch. 27; Sommerville 2006, Ch. 21). *Workload metrics* (number of CRDs categorized by stage in the process, priority, actor, or target IS areas) help actors allocate resources and find bottlenecks in work arrangements. *Process time metrics* help actors evaluate and plan work: cycle time (from CRD creation to changes implemented), reaction time (from creation to analysis), CRD processing time (from creation to change implementation decision), change engineering time (from implementation decision to accepted testing), the percentage of tests failed, and the percentage of CRDs lacking sufficient information for analysis. *Process breakdown metrics* (number of breakdowns, their causes and effects) enable actors to track breakdowns, eliminate their causes, and create procedures for recovery. They together with the *quality metrics* help to find suitable cases for process redesign. Relevant information (e.g., breakdown situations) must be stored in the KBL and requests must not leak through alternative media (e.g., telephone).

Dynamic task reconfiguration services

According to the meta-design of DIS, a relatively high level of freedom in the use of the layer is to be provided. Actors must be able to experiment with their tasks and tailor the layer if it improves performance without magnifying the change management risks. Task reconfiguration requires built in flexibility in work tasks and the layer.

The Inter-connected Role Layer

The inter-connected role layer aims at deepening the shared understanding among actors of the organizational context of their tasks. It provides actors in functional roles with redundant information (Nonaka 1994, 25) about the work of other participants. As the interdependency of tasks is very high, this ‘enlarged’ understanding reduces the number and severity of breakdowns caused by misconceptions and provides the basis for holistic process understanding needed to assess the current work methods and the ways they could be improved (Käkölä 1996a).

Redundant information services

Redundant information services explain how the processes of a CMO are run, what the responsibilities of different roles are, and how actors in these roles interact. They complement the learning services with information on interaction between tasks associated with functional roles. Table 1 depicts the four dimensions of information providing a holistic understanding of the work arrangements. The dimensions differ according to the focus and scope of the work related knowledge. Redundant information is also promoted by enabling actors to examine CRDs during all stages of CM. All actions should be explicitly stored in CRDs as this helps actors understand the work done by actors in other functional roles. The layer also provides a test environment where it is possible to simulate and actively experiment with different roles and corresponding tasks (c.f., Käkölä 1995; Käkölä & Koota 1999a).

The Design Product Effectiveness Hypotheses of the Business-system Layer of the ISDT for Dual CMIS

Design product effectiveness hypotheses of the ISDT inform (1) practitioners by clarifying the benefits that are expected to be achieved from using system instances aligned with the ISDT and (2) researchers by suggesting testable research hypothesis (Markus et al. 2002). The hypotheses are: (H1) The DCMIS instances (hereafter “DCMIS”) fol-

lowing the ISDT reinforce standardized, measurable, traceable, and transparent change management. (H2) When H1 holds, the use of DCMIS is likely to increase actors' motivation and sense of responsibility. (H3) When H2 holds, the use of DCMIS is likely to improve the planning and documentation of changes. (H4) When H3 holds, the use of DCMIS is likely to enhance coordination and to reduce the number and severity of breakdowns and the time needed to recover from them. (H5) When H4 holds, the use of DCMIS is likely to shorten the cycle time of change management, improve the quality of the organizational IS, and reduce the total resources required. (H6) When H5 holds, actors are likely to use the freed resources to improve their practices and DCMIS, for example, by documenting breakdowns and their causes and accumulating expertise information in KBL. (H7) When H6 holds, the CMO is likely to perceive DCMIS more useful and use it more actively. The positive, self-reinforcing cycle continues from H1.

Table 1. Learning and Redundant Information Services Contrasted

	Focus on work tasks	Focus on IS functions
Learning services (scope on tasks)	How do I perform an installation of a new change?	Where are the new changes, ready to be installed, stored in CMIS?
Redundant information services (scope on overall work context)	Who tests this new change? What information does he/she need to do it?	How do I inform the change initiator to test the new installed changes?

Table 2. Services of the Meta-design of the ISDT for Dual Change Management IS

Layer / Services	Operationalization of the Services in the ISDT for Dual Change Management IS
<i>Business-system Layer</i>	
Communication and resource allocation	Communication support is provided for automatic notification of changes to relevant persons and for informal non-structured communication. Resource allocation is tied to functional work roles, which can be designed centrally and changed flexibly.
Breakdown management	Previous actions taken regarding to a CRD are visible. Algorithms are transparent and traceable. Actions can be cancelled. Knowledge about the expertise and authority of the personnel is visible. Knowledge about the common breakdowns is accumulated and available.
Learning	The manual and computerized tasks of work roles are integrated holistically. The services are not separate entities outside the IS use context.
Performance monitoring	Personal metrics on work load, cycle times, work quality, and breakdowns are automatically stored in the knowledge-base layer. Personal metrics are visible to the associated person. The goals, baselines, and current averages of the role and CMO level metrics are visible to everybody.
Dynamic task reconfiguration	The layer is flexible to use (only a few compulsory data fields, ability to skip sub-processes, etc.) and the user interface, searching facilities, and simple task support can be customized as long as the change management process is not endangered.
Redundant information	Process models and database views depict the responsibilities and inter-dependencies between actors in the change management process. Other actors' work is visible through CRDs and traces of performed actions. Actors can experiment with different roles in a test environment.
<i>Project-system Layer</i>	
Argumentative dialogue	Discussion forums and other tools support semi-structured argumentation based on documented evidence.
Benchmarking	Statistical functions enable the analytical comparison of performance metrics. Standardized reports and metrics of the business-system layer help internal benchmarking.
Modeling	Process and data modeling functions enable the implementation and instantiation of these models in the learning services and corresponding software functions while reinforcing rigorous change management with respect to the changes of the business-system layer.
Simulation	These services support the simulation of alternative change management process redesigns.
Authoring	These services support the construction of the learning services for actors.

The Meta-design of the Project-system Layer of the ISDT for Dual Change Management IS

The project-system layer (Table 2) provides the services for cross-functional teams to assess and redesign the CM process and the services of the business-system layer. There are three prerequisites (Käkölä 1996a): (1) Actors must understand holistically their own work and work of other CM actors. The services of the business-system layer help actors in this. (2) Performance measures are needed to objectively assess how the processes are run (c.f., Chrisis et al. 2006). They are available through the performance monitoring services. (3) Extensive knowledge of the current

and past work practices must be available for redesigning processes. This information is stored in the KBL.

Development teams assess CM practices and their weaknesses. Argumentative dialogue services (Käkölä 1996b) support the conceptualization of work-related dilemmas and objectives. Benchmarking helps the team to increase its internal diversity and search for the best internal and external work practices. IT solutions supporting argumentation through semi-structured communication and group decision-making can be utilized. For benchmarking purposes, the layer exploits the metrics data collected by the performance monitoring services (Käkölä & Koota 1999b). KBL preserves information about all work arrangements and the project-system layer enables the statistical analysis of the data. Teams can use the modeling services to innovate new process and IS designs that best leverage the lessons learnt from benchmarking and suit the local conditions of CMO. Simulation services enable experimentation with the designs and link the design and implementation of work processes, helping bridge the design-use dualism. After the new solution has been decided upon, the generated process models can be used to design learning and redundant information services. If it necessitates changes in the application software implementing the business-system layer, the changes and associated training materials must be implemented through the CM process. The materials can be constructed using the authoring services that include tools for making narrative and graphical instructions.

The Meta-design of the Knowledge-base Layer of the ISDT for Dual Change Management IS

The knowledge-base layer is the repository of current and historical process information (e.g., performance measures, process descriptions, and instructions). In the ISDT for DIS, this information is stored in an abstracted form including data on the level of work processes and functional roles, not on the level of individual requests or actors. In the ISDT for DCMIS, the role of KBL is enlarged to include the CRDs and information about common breakdowns, their causes, and solutions. KBL provides query and browsing services for both standard queries, necessary for actors working in functional roles, and ad hoc queries supporting redesign projects and breakdown management.

Change Management Practices and Information Systems - Case Metso Paper

Metso Paper is a leading supplier of paper and board machines and automation systems in the world. Its global operations are enabled by an IS architecture called Profis. In the beginning of the research period, the installation of Profis was ending and the interest had shifted to change management and further development of the IS architecture. The CMO had been founded six months before the research started. It focused strongly on corrective maintenance due to the early stage of the life cycle of Profis. This section studies CM from the perspective of corrective changes. CMIS of Metso Paper is analyzed through the ISDT for DCMIS to study the validity and utility of the ISDT.

Research Setting and Methods

This research uses the single case study method suited for studying complex phenomena in their own context (Yin 2003; Benbasat, Goldstein & Mead 1987). The holistic scope of the meta-design hampers the application of survey or experimental methods and the meta-design cannot be separated from the research context. The method has elements of descriptive, exploratory, and explanatory studies because the meta-design is assessed in a new context (Yin 2003). The epistemological stance is interpretive as the focus is to study how CMIS influences and is influenced by its context and how this process can be analyzed through the meta-design of the ISDT for DCMIS (Klein & Myers 1999). The case study proceeds in two phases. First, the similarities and differences between CMIS and the ISDT are analyzed. Many problems should be perceived if CMIS does not comply with the ISDT. Second, the perceived problems in the use of CMIS are collected and contrasted to the results of the first phase.

Table 3. Research Methods Used in the Analysis of the Perceived Problems in the Use of CMIS

	Focused interviews	Change requests	Observations
Nature	Qualitative	Mainly quantitative	Qualitative
Influence of researchers	Moderate (minimized by using an unbiased frame of questions)	Low (data was accumulated independently from the research)	Varied depending on the level of participation
Collection method	Focused interviews with the members of the CMO	Change requests (e-mails) accumulated and stored	Field notes collected during the research process

Three sources of data were used for triangulation (Table 3). First, seven interviews were made during six months. Their duration ranged from 30 to 60 minutes. The interviewees represented all the roles participating in change management to ensure multiple interpretations of the reality were respected (Klein & Myers 1999). Second, almost 300 e-mails, each consisting of one or more change requests concerning CMIS, were analyzed to find out the needs

the actors had for CMIS. The requests were categorized according to this need dimension and relative frequencies were examined. Third, during the first three months of the research, the second author performed participant observation (Yin 2003) while working in the roles of a researcher and an IS specialist in the CMO. A research diary was collected and used to affirm and challenge the analysis of other types of data.

Change Management at Metso Paper

Several organizations participate in change management. Sites are responsible for the operational use of Profis. In addition, there is a layered support organization consisting of regional support centers and the centralized CMO acting as a global service provider for the sites. External organizations provide systems engineering and other services.

Change Management Process

The local feedback and error reports are collected and processed by the main users and the site's local support organization. If necessary, the issues are escalated to regional help desks for small local adjustments of the Profis installations. If the issue is of global concern, it is escalated to the CMO. The multi-layered design offers fast relief in local problems and lets the CMO concentrate on issues of highest importance. In the CMO, the requests are prioritized and assigned to specialists. After assessment, the CMO makes a decision regarding the implementation of the corrective change. Most of the engineering work is outsourced to third party vendors. The initiator then performs release testing in a test environment. If the changes are accepted, the new system components, installation instructions, and changes in documentation are delivered to all sites with relevant system versions for implementation.

Change Management IS (CMIS)

Metso Paper has been using its global Lotus Domino application infrastructure for knowledge management and process coordination associated with change management. CMIS supports organizational communication, coordination, and remembering of the CMO. The collection and assessment of corrective needs is supported by a helpdesk application. The requests accepted for engineering by the CMO are processed in another application. It stores information about all regional Profis versions and uses a layered document structure where solutions to a request are divided into detailed solution documents describing the implementation of the solutions in particular system version(s). Based on the solution documents and regional information, it automatically creates delivery documents for all sites using the system version that requires the change. Applications direct the change management workflow by linking each CRD to a certain stage in the process through status flags. Flow of a change from the initial requests to version-specific solution documents and site-specific delivery documents can be easily tracked. Statuses are also used to control the way a document can be edited, thus enforcing the standardization of the process.

Assessing CMIS as to the Design Product Hypotheses of the ISDT for Dual Change Management IS

Traces of functions resembling all the services of the business-system layer of DCMIS can be found from CMIS. However, the resemblance is very low except for the communication, resource allocation, and task reconfiguration services (Table 4). CMIS also expresses characteristics indicating non-transparency of technology. Hence, traces of problems associated with the black box nature of CMIS should manifest in the change management work. The services prescribed by the project-system layer of the ISDT for DCMIS are also poorly supported (Table 4). Dialogue and benchmarking tools support to a certain extent the assessment of work practices but implementation and simulation support for process redesign hardly exists. The absence and primitiveness of the services indicate that the focus of CM work has been on routine work, endangering the redesign of work practices and supporting IS in the long run. The work-related knowledge is accumulated in CMIS but it is physically and logically disintegrated. The lack of a KBL can negatively affect routines and process redesign, as knowledge about the past cannot be effectively used.

Perceived Problems in Change Management Work and the Use of CMIS to Support It

Problems in Metso Paper's CM work and use of CMIS are studied from the viewpoint of CM actors.

Overview of the Perceived Problems

The six main problem categories are summarized in Table 5. The only category expressed by all the interviewees was *problems in finding information in CMIS*. Most statements in this category concerned the information in the CRDs but several interviews also highlighted problems in finding necessary work instructions. Six interviewees considered *the frequent breakdowns in work routines* a problem. Statements concerning breakdowns (e.g., delays

when documents were handed off from one sub-process to another) in work arrangements due to technical and process factors were included. Six interviewees experienced *problems understanding the functions of CMIS*. Most of the problems related to the complex algorithms and functions such as the automated delivery procedure stating the need to install a change in a certain site. The *insufficient CMIS learning material and training* category related to a perceived lack of support facilities for CM activities and for using CMIS. Problems belonging to this category were lack of training, inaccurate and outdated learning material that was hard to locate, and lack of built-in user support in CMIS. *Missing understanding of the overall work process and responsibilities* was another problem category. Several interviewees indicated that their responsibilities were not well defined or stable. Managers mostly expressed *performance monitoring problems*, including the lack of process metrics and ad hoc reporting facilities. The workers were skeptical about performance monitoring and doubted how well it could reflect the complex reality.

Table 4. Comparison of the Business-system and Project-system Layers of CMIS and the ISDT for Dual Change Management IS

DIS Services	Assessing CMIS with respect to the design product hypotheses of the ISDT for DCMIS	Similarity
<i>Business-system Layer</i>		
Communication and resource allocation	Informal and structured automated e-mail functions are provided. The organizational transparency of communication is limited. CMIS resource allocation is based on work roles and can be reconfigured quite flexibly.	Moderate
Breakdown management	Document life cycle is visible. Algorithms used are not transparent and traceable. Actions cannot be cancelled. Information on the common breakdowns and the expertise and authority of the personnel are not accumulated.	Low
Learning	Learning material is partly outdated and can only be found in work instruction documents separate from CMIS. The use of process models and role-based descriptions in the material is not extensive.	Low
Performance monitoring	Performance information is gathered about workload and cycle times but mainly used for managerial purposes. No targets or standards are stated.	Low
Dynamic task reconfiguration	Possibilities for customization exist but customization requires technical expertise. Built-in freedom and flexibility are relatively high in system use.	Moderate
Redundant information	Other actors' work is visible through CRDs and views of shared document databases. Use of process models and narratives to describe inter-connections between roles is limited. No official training environment has been established or used.	Low
<i>Project-system Layer</i>		
Argumentative dialogue	A change management discussion forum and informal e-mail messaging are available. Semi-structured argumentation is not actively encouraged.	Low
Benchmarking	Statistical views used to summarize process data help compare work arrangements to some extent. Consistent benchmarking practices have not been established.	Low
Modeling	Simple flowcharting tools are available.	None
Simulation	None	None
Authoring	Training sessions, meetings, e-mail lists, and user instructions are used. Learning services are not constructed for and provided on-line through CMIS.	Low

Table 5. Frequencies of perceived problem categories according to interviews (Roles of the interviewees: CI - change initiator, A - analyst, E - engineering group, VO - version owner, Co - coordinator; n - total amount)

	CI (n=1)	A (n=2)	E (n=1)	VO (n=1)	Co (n=2)	Σ/n
Problems with finding information in CMIS	1	2	1	1	2	7/7
Frequent breakdowns in routines	1	1	1	1	2	6/7
Problems with understanding CMIS functions	1	2	1	1	1	6/7
Insufficient training and learning material	1	1		1	1	4/7
Work process and/or responsibilities unclear	1		1	1	1	4/7
Problems monitoring work process		1			2	3/7

Relations of the Perceived Problems to the ISDT for Dual Change Management IS

The problem categories are analyzed in light of the differences between the ISDT and CMIS to point out how the categories can be related to CMIS by using the ISDT as an analytical tool.

Communication and Resource Allocation Services

CMIS played a key role in organizational communication and remembering according to all interviewees. The comment by a coordinator in CMO illustrates the role of CMIS as the backbone of the change management work:

“The databases [i.e., CMIS] are very important. They let you see who has done what, when, and why. Actually, they are the main glue holding our organization together because we are so dispersed.”

Actors were relatively satisfied with the way CMIS promoted intra-organizational communications. This was aligned with the high resemblance of communication services of the DCMIS and CMIS (e.g., presence of both structured and non-structured communication support). CMIS-related change requests indicated that actors had actively participated in the development of notification functions. The resource allocation services of CMIS were based on work roles and related access rights. Only some work process breakdowns occurred due to workers' lack of authorization in exceptional situations but the risks in CM require careful consideration of actions in such situations.

Breakdown Management Services

Technical and process-related breakdowns were frequent partly due to the technical and organizational complexity associated with CM. But many of them also seemed to result from missing redundant information and holistic process understanding. A member of the engineering team stressed the importance of breakdown management:

“The routine work procedure covers 80-90% of the cases. Managing the exceptions consumes a lot of time. They are usually caused by some unexpected technical problems.”

A coordinator addressed the breakdowns to missing holistic understanding of work:

“I guess everybody thinks they know how this [CM] process goes, but I don't think that many people really do.”

Several interviewees indicated that hand-offs between processes were problematic.

“The change requests seem to stall when the responsibility for them is transferred from one person to another.”

“I know that some issues have just been forgotten after they have been handed off.”

Actors could not understand how their actions affected the subsequent process steps. A system engineer stated::

“I do not know what all the buttons do. I'm quite satisfied with knowing what I have to do and how to do it.”

An example of the importance of redundant information in avoiding breakdowns is the notification sending functionality. It was made transparent by enabling actors to choose the recipients of notifications about a CRD from a list of prospects. This change caused anxiety and communication breakdowns because actors had trouble deciding who should know about the changes made. Inexperienced users either selected nobody or all persons available as recipients. The increased transparency of technology can thus increase the demand of redundant information, as the understanding of links between the roles of workers becomes vital. The example also provides support for the meta-requirement of the ISDT that both technical and work related issues must be developed in concert.

In line with the ISDT, a repository containing interest and responsibility areas of actors would help actors recover from breakdowns by making their expertise and authorization visible. The lack of user training, inconsistent learning materials and the missing support for canceling and rolling back actions already committed also cause breakdowns.

Learning Services

Actors understood the connections between manual work tasks and CMIS functions weakly. A version owner stated:

“The change requests have so many statuses that it's hard to know what they mean and which ones to use.”

“It is especially difficult for me to understand the linking between the applications [of CMIS]. These links are not very well represented in instructions.”

The poor understanding of the connections between manual and computer-supported tasks induced many of the other problems detected in the CM work and CMIS use and facilitated the institutionalization of CMIS.

Performance Monitoring Services

“It is very hard to tell how we have managed to improve our process with new tools and personnel when

quantitative information on the process performance is not available.”

Efforts were made during the research period to introduce performance monitoring in CMIS. These functions were not fully exploited when the period ended but managers were able to identify some bottlenecks. A manager stated:

“Even on the basis of this [metrics] data we have been able to reduce some inefficiency.”

Managers used the services to identify the overall cycle times and relative durations of tasks. Workers did not anticipate or require the services. The practical use of the services thus did not correspond with the ISDT for DIS. However, if appropriate incentive schemes had been devised based on the services, workers might have become more proactive and autonomous in improving their routines, as called for by the ISDT. The perceived problem of frequent process breakdowns can thus be connected to inadequate performance monitoring services.

Dynamic Task Reconfiguration Services

CMIS offered a high level of flexibility to help actors deal with complex and unexpected situations. It enabled the establishment of personal arrangements to support work tasks, as a member of the engineering group states:

“We have made up our own coding system. This is the way I mark down for Jim [demonstrates this with CMIS] that I’m working on the case.”

But the flexibility also caused perceived problems. The variety of ways CMIS could be used hampered finding information from it. For example, a change initiator had difficulties monitoring the processing of his initiatives:

“It is sometimes difficult to find out how a change request has proceeded, because the request may have been processed by several persons who all have different methods of marking down their comments.”

Redundant Information Services

Actors’ work-related knowledge was limited to their own tasks and corresponding CMIS functions. The overview of the process, responsibilities, and inter-connections of actors was not uniformly clarified in the learning materials. Inadequate redundant information hampered the use of transparent functions (c.f., the sending of notifications) and caused breakdowns because workers did not know their responsibilities, were unsure which events required their response, forgot to act in proper parts of the process, and did not understand the consequences of their actions.

Services of the Project-system Layer of the Change Management IS

The near absence of the services of the project-system layer of the ISDT was due to the immaturity of the CMO and lack of resources. The focus was in processing the large flow of requests. It is impossible to estimate the degree to which the missing or limited services of the project-system layer caused the perceived problems. No serious consequences were likely to be indicated in the research period. After all, the services support the long-term organizational effectiveness. However, the vast number of change requests concerning CMIS shows that the needs were evolving and actors were genuinely interested in developing their work practices. The services of the project-system layer could thus be useful for assessing these needs and supporting their implementation.

Knowledge-base Layer of the Change Management IS

Effects of the disintegration of the KBL can be seen from several problem categories. The problems in finding information from CMIS were induced by the missing linking of different categories of work-related explicit knowledge.

“It’s hard to understand how this process is run, because the important information about it is located in different places, partly outdated, and hard to find. I guess this is especially problematic for new workers.”

Disintegration of the KBL caused problems in implementing the learning and redundant information services and can be seen as a reason for the problems actors had in understanding CMIS functions and their work responsibilities. Problems in monitoring work processes are attributable to the lack of performance information in the KBL.

Assessment of the Empirical Research Findings

The case study provides insights on the applicability of the ISDT for Dual Change Management IS and the ISDT for Dual IS in analyzing and further developing the Change Management IS to correspond more closely with the ISDTs.

Insights from Analyzing the Change Management IS

The ISDT for Dual CMIS could be used to analyze how different aspects of CMIS corresponded with the ISDT. The differences between CMIS and the ISDT could then be used to explain some of the perceived problems in CMIS use. Traces of functions resembling the services of the business-system layer could be found in CMIS. The services

of the project-system layer were largely missing indicating that the focus of work had been to achieve efficient routines in the short term, which posed a threat to organizational long-term effectiveness. Due to the disintegration, the KBL as prescribed by the ISDT was practically missing, thus hampering both the routines and process redesign.

The ISDT for DIS can be used to identify the presence or absence of key services in an operational IS. However, the complexity and domain independent nature of the ISDT cause problems in applying it as an analytical tool. The specialization of the ISDT into a domain specific ISDT requires considerable effort and domain knowledge.

Several perceived problem categories were connected to the characteristics of CMIS. The missing understanding of work processes could result in breakdowns even when the technology was relatively transparent. The strength of the ISDT for DIS is that it underlines the transparency of technology and places technology in its organizational context.

Applying the ISDT for Dual Change Management IS to Enhance the Change Management IS

The empirical research revealed three development possibilities to remedy the perceived problems: promoting the holistic understanding of work, enhancing breakdown management, and introducing work process redesign support. The learning materials in Metso Paper utilized simple but inconsistent flow diagrams, did not handle exceptions, and did not depict the actors responsible for processes, data flows between processes, and the role of CMIS in coordinating and automating processes. When consistent modeling principles have been adopted and the process models and other learning materials have been instantiated, they should be stored in the knowledge-base layer, made available to actors and maintained systematically. The knowledge-base layer and CMIS could be interlinked through, for example, context sensitive drill downs from CMIS functions to related process models and detailed work instructions.

New tools could be introduced to help actors recover from breakdowns that often occurred because actors did not know who possessed the knowledge or authority to resolve unexpected situations. As the ISDT indicates, the problem could be remedied by using the knowledge-base layer containing the expertise and authority areas of the actors to enhance communication and prevent breakdowns. The KBL would mainly be used to find the person(s) who could help with a problem and the persons who should be notified about a change.

In the long run, organizational designs, practices, and IS services for supporting process redesign are essential for a CMO. In Metso Paper, they neither emerged nor were actively established. However, if redesign project teams were established, tools for the teams could be incorporated with low cost through the existing groupware infrastructure. The definition and modeling of the processes provide the basis for improvement of the performance monitoring and benchmarking services of Metso Paper. The discussion databases already used could be leveraged to enact forums for redesign and provide project teams with support for non-structured dialogue on CM process-related issues. Groupware does not support argumentation in a strict sense because no clear rules for argumentation are present. Yet, the issues can be discussed so that conversations are focused, visible, and stored for further reference.

Conclusions and Future Research

As evidenced by the case study, change management IS are likely to fall short in helping change management organizations maintain the operational effectiveness of the organizational IS, unless a theory-based roadmap and adequate resources are used to design them. This paper (1) identified the ISDT for Dual Information Systems as a potentially effective kernel theory for building such a roadmap, (2) presented a research model that can be modified to validate any domain-independent ISDTs, contributing to design research (Hevner et al., 2004) in general, and (3) used the model to initiate the validation of the ISDT for Dual Information Systems. A new ISDT for the change management domain was created and used to identify, analyze, and alleviate problems encountered by a change management organization. The validity of the ISDT for Dual Change Management IS and the ISDT for Dual Information Systems could not be refuted because the ISDT for Dual Change Management IS could be utilized to explain and generate solutions to the perceived problems in Metso Paper's use of the Change Management IS. With the roadmap and the groupware infrastructure in place, companies like Metso can implement even the most advanced services of the ISDT for Dual Information Systems in a lightweight manner.

The ISDT for Dual Information Systems was applicable for designing the ISDT for Dual Change Management IS. It thus served as a kernel theory for developing a domain-specific ISDT, showing that the information systems research field has (finally) matured to a point where theory development can be based on "paradigms endogenous to the area itself" (Walls et al. 1991, 37). The extant IS literature has not utilized ISDTs as endogenous kernel theories for developing new design theories.

The specialization of the meta-design of the ISDT for Dual Information Systems was found nontrivial because the

domain-independent meta-design leaves room for the subjective interpretations of the designers of the domain-specific ISDT and requires in-depth domain knowledge. However, the ISDT for Dual Change Management IS is more practical and easy to understand than the ISDT for Dual Information Systems, thus making the ISDT for Dual Information Systems increasingly tractable for further theoretical development and for practical applications in designing new IS and evaluating and improving existing ones. Future research is thus expected to reach even better results in applying, refining, and validating the ISDT for Dual Information Systems in different domains.

References

- Alter, S. *The Work System Method: Connecting People, Processes, and IT for Business Results*. Work System Press, Larkspur, CA, USA, 2006.
- Benbasat, I., Goldstein, D., and Mead, M. "The Case Research Strategy in Studies of Information Systems," *MIS Quarterly* (11:3), 1987, pp. 369-385.
- Beresoff, E., and Davis, A. "Impacts of Life Cycle Models on Software Configuration Management," *Communications of the ACM* (34:8), 1991, pp. 105-117.
- Chrissis, M.B., Konrad, M., and Shrum, S. *CMMI®: Guidelines for Process Integration and Product Improvement*. Addison-Wesley, SEI Series on Software Engineering (Second edition), USA, 2006.
- Davenport, T.H., De Long, D.W., and Beers, M.C. "Successful Knowledge Management Projects," *MIT Sloan Management Review* (39:2), 1998, pp. 43-57.
- Davis, A., and Sitaram, P. "A Concurrent Model of Software Development," *ACM SIGSOFT Software Engineering Notes* (19:2), ACM Press, 1994, pp. 38-51.
- Eriksson, I., Hellman, R., and Nurminen, M.I. "A Method for Supporting Users' Comprehensive Learning," *Education & Computing* (4:4), 1988, pp. 251-264.
- Eriksson, I., and Nurminen, M.I. "Doing by Learning: Embedded Application Systems," *Journal of Organizational Computing* (1:4), 1991, pp. 323-339.
- Gasser, L. "The Integration of Computing and Routine Work," *ACM Transactions on Office Information Systems* (4:3), 1986, pp. 205-225.
- Haikala, I., and Märijärvi, J. *Ohjelmistotuotanto*. Talentum Media, Finland, 2006.
- Heidegger, M. *The Question Concerning Technology*. Harper & Row, New York, 1977.
- Heikkilä, M. *Muutostenhallinnan Lähtökohdat, Mallintaminen ja Järjestelmätuen Vaatimukset – Case Valmet*. Master's thesis, Department of Computer Science, University of Jyväskylä, Finland, 1999.
- Henry, J., and Cain, J. "A Quantitative Comparison of Perfective and Corrective Software Maintenance," *Journal of Software Maintenance* (9:5), 1997, pp. 281-298.
- Hevner, A. R., March, S. T., Park, J., and Ram, S. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), 2004, pp. 75-105.
- Hipkin, I. "Evaluating Maintenance Management Information Systems," *European Journal of Information Systems* (5:4), 1996, pp. 261-272.
- International Organization for Standardization (ISO). *ISO/IEC 14764:2006(E). Software Engineering — Software Life Cycle Processes — Maintenance*. ISO, Geneva, Switzerland. IEEE, Piscataway, USA, 2006.
- International Organization for Standardization (ISO). *ISO/IEC 20000:2005. Information Technology-Service Management-Part 1: Specification*. ISO, Geneva, Switzerland, 2005. <http://www.iso.org>
- Joeris, G. "Change Management Needs Integrated Process and Configuration Management," *ACM SIGSOFT Software Engineering Notes* (22:6), ACM Press, 1997a, pp. 125-141.
- Joeris, G. "Cooperative and Integrated Workflow and Document Management for Engineering Applications," in *Proceedings of the 8th International Workshop on Database and Expert Systems Applications*, Toulouse, France, IEEE, 1997b, pp. 68-73.
- Klein, H., and Myers, M. "A Set of Principles for Conducting Interpretive Field Studies in Information Systems," *MIS Quarterly* (23:1), 1999, pp. 67-93.
- Kraul, R., and Streeter, L. "Coordination in Software Development," *Communications of the ACM* (38:3), 1995, pp. 69-81.
- Käkölä, T. "Increasing the Interpretive Flexibility of Information Systems through Embedded Application Systems," *Accounting, Management & Information Technologies* (5:1), 1995, pp. 79-102.
- Käkölä, T. *Dual Information Systems in Hyperknowledge Organizations*. Turku Centre for Computer Science (TUCS) Dissertations 2, University of Turku, Finland, 1996a. [Http://www.cs.jyu.fi/~timokk](http://www.cs.jyu.fi/~timokk).
- Käkölä, T. "Designing and Deploying Coordination Technologies for Fostering Organizational Working and Learning: From Vision to Reality?" *Scandinavian Journal of Information Systems* (7:2), 1996b, pp. 45-74.

- Käkölä, T. "Best Practices for International eSourcing of Software Products and Services," in *Proceedings of the 41st Annual Hawaii International Conference on Systems Sciences*, IEEE, 2008.
- Käkölä, T., Koivulahti-Ojala, M., and Liimatainen, J. "An Information Systems Design Theory for Integrated Requirements and Release Management Systems," in *Proceedings of the 42nd Annual Hawaii International Conference on Systems Sciences*, IEEE, 2009.
- Käkölä, T., and Koota, K. "Dual Information Systems: Supporting Organizational Working and Learning by Making Organizational Memory Transparent," *Journal of Organizational Computing and Electronic Commerce* (9:2&3), 1999a, pp. 205-232.
- Käkölä, T., and Koota, K. "Redesigning Computer-Supported Work Processes with Dual Information Systems: the Work Process Benchmarking Service," *Journal of Management Information Systems* (16:1), 1999b, pp. 87-119.
- Malone, T., and Crowston K. "The Interdisciplinary Study of Coordination," *Computing Surveys* (26:1), 1994, pp. 87-119.
- Mandiwalla, M., and Olfman, L. "What Do Groups Need? A Proposed Set of Generic Groupware Requirements," *ACM Transactions on Human-Computer Interaction* (1:3), 1994, pp. 245-268.
- Markus, M.L., Majchrzak, A., and Gasser, L. "A Design Theory that Supports Emergent Knowledge Processes," *MIS Quarterly* (26:3), 2002, pp. 179-212.
- Nance, W. "An Investigation of Information Technology and the Information Systems Group as Drivers and Enablers of Organizational Change," in *Proceedings of the 1996 ACM SIGCPR/CIGMIS Conference*, Denver, USA, 1996, pp. 49-57.
- Nonaka I. "A Dynamic Theory of Organizational Knowledge Creation," *Organization Science* (5:1), 1994, pp. 14-37.
- Nurminen, M.I. *People or Computers: Three Ways of Looking at Information Systems*. Studentlitteratur & Chartwell-Bratt, Lund, Sweden, 1988.
- Orlikowski, W. "The Duality of Technology: Rethinking the Concept of Technology in Organizations," *Organization Science* (3:3), 1992, pp. 398-427.
- Parnas, D., and Clements, P. "A Rational Design Process: How and Why to Fake It," *IEEE Transactions on Software Engineering* (12:2), 1986, pp. 251-257.
- Pressman, R. *Software Engineering: A Practitioner's Approach*. The McGraw-Hill Companies (Sixth edition), New York, USA, 2005.
- Ross, J.W., Weill, P., and Robertson, D. *Enterprise Architecture As Strategy: Creating a Foundation for Business Execution*. Harvard Business School Press, Boston, MA, USA, 2006.
- Salo, A., and Käkölä T. "Groupware Support for Requirements Management in New Product Development," *Journal of Organizational Computing and Electronic Commerce* (15:4), 2005, pp. 253-284.
- Schmidt, K., and Bannon, L. "Taking CSCW Seriously: Supporting Articulation Work," *Computer Supported Cooperative Work (CSCW)* (1:1-2), 1992, pp. 72-40.
- Sherer, S. "Using Risk Analysis to Manage Software Maintenance," *Journal of Software Maintenance* (9:6), 1997, pp. 345-364.
- Sommerville, I. *Software Engineering*. Addison-Wesley (8th edition), Harlow, England, 2006.
- Stark, G., and Oman, P. "Software Maintenance Management Strategies: Observations from the Field," *Journal of Software Maintenance* (9:6), 1997, pp. 365-378.
- Stein, E.W., and Zwass, V. "Actualizing organizational memory with information systems," *Information Systems Research* (6:2), 1995, pp. 85-117.
- Swanson, B. "The Dimensions of Maintenance," in *Proceedings of the 2nd International Conference of Software Engineering*, IEEE Computer Society Press, CA, USA, 1976, pp. 492-497.
- Swanson, B. "IS Maintainability: Should it Reduce the Maintenance Effort?" *Proceedings of the 1999 ACM SIGCPR Conference on Computer Personnel Research*, 1999, pp. 164-173.
- Truex, D., Baskerville, R., and Klein, H. "Growing Systems in Emergent Organizations," *Communications of the ACM* (42:8), 1999, pp. 117-123.
- Walls, J., Widmeyer, G., and El Sawy, O. "Building an Information System Design Theory for Vigilant EIS," *Information Systems Research* (3:1), 1992, pp. 36-59.
- Zuboff, S. *In the Age of the Smart Machine - The Future of Work and Power*. Heinemann Professional Publishing, Ltd., Oxford, England, 1988.
- Yin, R. *Case Study Research: Design and Methods*. Sage Publications (Third edition), Newbury Park, CA, USA, 2003.