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Reconciling Knowledge Management and Workflow Management Systems: The Activity-based Knowledge Management Approach

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Abstract: Current trends in collaborative knowledge management emphasize the importance of inter- and intra-organizational business process support. Enactment of business processes has primarily been a domain of workflow management systems. In this paper we propose a hybrid architecture for reconciliation of knowledge management and workflow management systems in order to support process participants in organizations, who are increasingly distributed and need to share and distribute knowledge artifacts. Today one pressing challenge is to utilize software as to create, share, and exchange (knowledge) work in collaborative knowledge activities across locations, while still being business process aware. This paper develops a conceptual framework, discusses a software architecture, and presents examples of a software system implementation for activity-based knowledge management for global project teams.

Keywords: Workflow, Knowledge Management
Categories: H. 4.1, H. 4.3, D. 2.11, D. 4.1, D. 4.7

1 Introduction

Organizations face unprecedented competition, forcing them to offer exceptional levels of service – at whichever stage or sector of the productive business process they find themselves. As a consequence organizations need to communicate, collaborate, and coordinate their (knowledge) work activities, projects, and complex business processes in real-time [Zeng, 01] and on a global scale. Knowledge is seen as a critical factor in optimizing corporate performance. Knowledge work requires the interaction of many individuals, groups, and project teams. Participants interact and coordinate their work with others, regardless where they are and what sort of computer or mobile device they use. Today e-mail is the most popular application on the Internet and used to exchange ideas, documents and "knowledge-artifacts" in general. But still it remains a challenge to manage knowledge-based projects and coordinate work activities. Whilst systems such as knowledge management (KM) and workflow management systems (WfMS) are becoming more and more commonplace, it is still true to say that the links between work activities, their resources, and communications between the actors are not recorded in KM systems. An important goal knowledge management initiatives aim for is to record the history of creation, seamless access, distribution, and assessment of knowledge work. The interdependence of IT and information assets have never been greater than in the area of the new networked global economy. Efficient technology and communication infrastructure is a key factor to the success and viability of a modern, flexible, and adaptive organization. This leads to changing business objectives as well as changing communication practices. Organizations are forced to: manage and coordinate their product and service development processes; make their products and services available as quickly as possible; and to involve employees, customers, suppliers and partners in different stages of the business processes. Therefore organizations aim to resolve four major issues (in some instances with the help of KM systems): (a) coordination across departments, project groups and their various responsibilities, and applications; (b) boordination with their customers, partners, suppliers, distributors, retailers, employees and even competitors; (c) traceability of knowledge work at all stages of business processes regardless of location; and (d) adequate infrastructure to understand, evaluate, and monitor work activities and processes. The relatively new discipline of Knowledge Management has arisen as a result of the ongoing search by organizations for competitive advantage and leverage of their knowledge assets, allied with the progressive development of information systems. Two different schools of thought influence the literature on KM. The Japanese perspective [Nonaka, 95] distinguishes between explicit and tacit knowledge, and proposes the conversion between the two forms as the key to knowledge creation. The Western, mainly US view of knowledge is of a management process, with the systematic storage and retrieval of information in context.

The contribution of this paper is to present the Activity-based Knowledge Management approach as a conceptual basis for reconciling Knowledge Management with Workflow Management Systems. The underlying proposition of our approach is to associate work activities including their deliverables (e.g. artifacts) with time and cost related information with business processes (i.e. workflow instances). In essence, we think that for knowledge management activities support for ad hoc processes is crucial and do not aim to model knowledge-based business processes in advance. This contrasts a more traditional understanding of Workflow Management Systems. Therefore our approach focuses more on ad hoc process support rather than on techniques found in KM literature [e.g. Applehans, 98] and has more similarities with the approach presented by [Binbasioglu, Karagiannis, 00] and by [Karagiannis, 95]. The remainder of the paper is organized as follows: Section 2 elaborates on the conceptual framework for knowledge work activities. This is achieved by first decomposing knowledge work activities in the next section and then by presenting a "technology framework" in order to understand knowledge-based information systems along two orthogonal dimensions: Knowledge Usage and Knowledge Context. Section 3 discusses the building blocks of Activity-based Knowledge Management solutions. Section 4 proposes a software architecture for enabling process modeling and instantiation for Activity-based KM systems for global project teams. Conclusions are finally made in section 5.

2 Conceptual Framework for Knowledge-based work activities

Knowledge Management (KM) is often loosely defined in terms of processes, culture, and ways of communicating. KM, it can be argued, represents the processes that enable the organization to act, in response to the changing internal and external environments in which they operate. Drucker (1994) discusses a "knowledge society" where "knowledge workers" play a central role and "knowledge-based intangibles" such as product development know-how being the capital of the future. There are many framework proposed in the literature focusing on understanding key functionalities of information systems aiming to support Knowledge Management [e.g. Applehans, 98; Binbasioglu, Karagiannis, 00, Doculabs, 03] to name a few. Some of the proposed categories help us to gain a clear picture as to in which areas KM systems should provide IT support to organizations. In some categories KM systems on the market today are not sufficient, but require interfaces to systems such as workflow management systems, Groupware, or Project Management (PM) systems. Advances in the area of Internet Computing, WfMS, and KM are often seen as substantial for supporting distributed knowledge work. Cooperative knowledge work in teams is increasing and as a consequence the use of collaborative KM systems and WfMS are becoming more pervasive. WfMS have been defined as "technology based systems that define, manage, and execute workflow processes through the execution of software whose order of execution is driven by a computer representation of the workflow process logic" [WfMC, 95]. To fully understand the context of collaborative technologies for organizations it is important to first analyze the dimensions of current systems. In this paper our model to analyze collaborative technologies distinguishes two dimensions: Knowledge Usage and Knowledge Context as shown in Figure 1. Knowledge Usage is about the "paradigm" knowledge is used. In its simplest form knowledge is only retrieved. The next stage allows retrieval and sharing of knowledge. The following stage enables users to create workspaces by organizing knowledge artifacts using files and folder hierarchies. The distribution stage enables knowledge workers to distribute knowledge artifacts (objects) by using push/pull mechanisms. Finally the link stage allows retrieval, sharing, workspaces, distribution, and in addition allows links between all knowledge artifacts. The second dimension Knowledge Context reveals contextual information on knowledge artifacts. Generally we can say that the higher contextual information is the more process awareness is stored together with knowledge artifacts. In its simplest stage it allows auditing of knowledge artifacts. For example users may view timestamp information on creation and routing of artifacts. The second stage enables organizational modeling, i.e. to define persons, roles, departments, and other organizational constructs required to design organizational structure. Organizational models allow organizations to define a set of access rights and rules for artifacts. The third stage additionally enables process modeling. Process tracking enables administrators to view the progress of business processes and the progress of activities as the building blocks of processes. Finally Reporting and Analysis supports analysis of all previously explained stages, and statistical comparisons between them.

We find it useful to relate technologies on the market today to those two dimensions in order to elaborate our proposed Activity-based KM approach. Groupware systems usually provide very low knowledge context information but provide relatively high knowledge usage capabilities, since they enable users to retrieve, share, organize their work in workspaces, and to distribute artifacts. An example of a system also supporting linkage of knowledge artifacts will be presented in section 4. Document Management systems are increasingly integrated with WfMS as recent mergers demonstrate (e.g. Lotus Notes/OneStone). Project management (PM) software is still mostly viewed as a software for individuals (i.e. project managers) and rarely offers collaborative or business process aware solutions. Moreover, in most cases PM software is not integrated with corporate information systems and in fact is only utilized as a graphical modeling tool for outlining tasks. Most Knowledge Management systems on the market today are workspace-centered and provide only very simple forms to model organizational structures (e.g. using roles only, but not skills). It is interesting to note that nearly no KM system provides interfaces to business process modeling and enactment systems (the domain of WfMS). Most KM-systems enable users to retrieve knowledge artifacts from repositories, but rarely allow distribution and process awareness (see section 3 for examples). A modeled business process such as "customer order entry" can be modeled using a WfMS. However a modeled process can only be enacted (instantiated) as it was designed. If an exception occurs, a workflow administrator needs to re-model the process before the execution can continue. This limits the usability of WfMS in a world where constant adaptation to new situations is necessary and where teams are increasingly mobile and distributed. An example of an ad-hoc process is discussion of a project's design review using e-mail (Groupware). Workflow management systems are typically organizationally aware because they contain an explicit representation of organizational processes. In recent years there has been considerable attempts to merge workflow and knowledge management technologies [Dayal, 01]. Industrial research labs [Chen, 01] and product teams [Dustdar, 02; 04] have made significant steps forward. A WfMS can impose a rigid work environment on users, which often has a consequence. One example is among users who perform time-consuming manual "work arounds"; the consequence is lower efficiency and dissatisfaction with the system. Workflow automation provides unique opportunities for direction information flow and monitoring work performance. As a consequence WfMS enable continuous loops of sub processes such as goal setting, working, monitoring the work, measuring performance, recording and analyzing the outputs and evaluating the "productivity" of personnel. Users of WfMS often consider the controlling and monitoring possibilities as a "dark side" of these systems, which results in demotivating employees. A business process has well defined inputs and outputs and serves a meaningful purpose either inside or between organizations. Business processes and their corresponding workflows exist as logical models. When business process models are executed they have specific instances. When a workflow is instantiated the whole workflow is called a work case [WfMC, 95]. The WfMS enacts the real world business process for each process instance. A business process consists of a sequence of activities. An activity is a distinct process step and may be performed either by a human agent or by a machine. Any activity may consist of one or more tasks. A set of tasks to be worked on by a user (human agent or machine) is called work list. The work list itself is managed by the WfMS. The WfMC calls the individual task on the work list work item [WfMC, 95]. To summarize, a workflow is the instantiated (enacted or executed) business process, either in whole or in parts. During enactment of a business process documents, which are associated to tasks are passed from one task participant to another. In most cases this passing of documents or executing applications is performed according to a set of rules. A WfMS is responsible for control and coordination such as instantiating the workflow, assigning human or non-human agents to perform activities, generating worklists for individuals, and routing tasks and their associated objects such as documents between the agents. For an in-depth discussion on WfMS we refer to e.g. Bussler in [Bussler, 99].

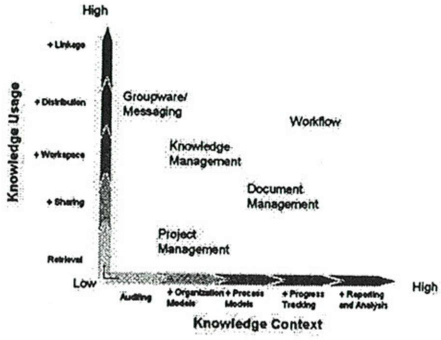

Figure 1: Technology Framework

Research shows that team performance is positively affected by communications between team members, as shown in [McDonough, 99]. Literature stresses the importance of the formal and informal communicative aspects of collaborative systems, which reflect the underlying structural dependencies in work settings [McDonough, 99]. Working in organizations is often characterized as "networks of commitments," as people in the organization send work through the systems [Winograd, 86]. Figure 1 suggests that KM systems of moving from currently being mostly "retrieval" oriented towards "collaborative" direction and on the business process spectrum some KM systems strive to support the spectrum of ad-hoc business processes and modeled processes as depicted in Figure 1.

3 Foundations of activity-based Knowledge Management

Knowledge can be viewed as information enriched with context. With context we mean information about the "who, when, how, and why". As an example, consider an "Explorer"-like view on a file system. This view allows the person to see documents (artifacts) stored inside folders. The name of such folders might reflect project names themselves. The mentioned view on these documents does not contain further contextual information on what a person (yourself, or others) actually have to do (did) with it (e.g. create another document, send an e-mail to customer, call partner organization, etc.). For example if the person in the above example needs to see who actually received a document stored in any given (project) folder, he is required to manually retrieve his e-mail box in order to find this information. This simple example shows that links between artifacts, such as documents or database information, and activities performed by persons are usually not stored in information systems such as KM or WfMS. However this linkage is of paramount importance for knowledge-intense business processes in order to provide contextual information on knowledge artifacts for processes such as new product development, which cannot be modeled using a WfMS. We propose activities as an important building block for reconciliation of KM systems and WfMS. Activities have multiple relationships with other entities highly relevant to information systems dealing with knowledge work, as depicted in Figure 2. Activities require resources (e.g. persons), documents, time, and deliver deliverables. Resources are required to perform activities. Those resources used for activities generate costs. The same applies to the time required to perform activities: it generates costs.

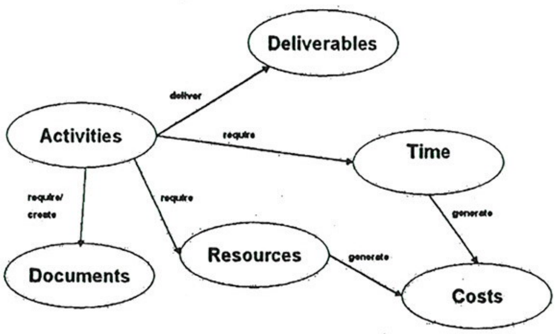

Figure 2: Activities and their relationships

4 Architectural Issues

In the following section we will provide an overview of architectural issues we are concerned with while designing an activity-based KM system called *Caramba* [Caramba Labs, 2004]. An in-depth presentation of the architecture or the software itself is beyond the scope and focus of this paper. However, we will discuss relevant issues based on our proposed activity-based KM approach in this section. Software prototype development began in 1997 and it evolved into a commercial product, which has been launched in 2001. Software architectures typically include the description of *components*, *connectors*, and *configurations* [Perry,92; Shaw, 96]. For this it is important to decompose a system into a well-defined set of components that have clear responsibilities [Parnas, 72]. Since architectures in the KM and WfMS area have to cope with and to integrate with various information systems installed in organizations we decided to strive for a middleware style rather than a classical client-server style. The following descriptions will point out the respective architectural style used in a particular layer or component. The Caramba software architecture [Dustdar, 04] is composed of multiple layers: middleware, client suite, and a persistence store. Objects and services are accessed through the ***Transparent Access Layer*** (TAL) from the CarambaSpace platform (middleware). Depending on access mechanisms and the requested services (e.g. via Java client with RMI protocol or via Web browser with http), Caramba provides a unique way to handle requests using a meta model framework to describe content and separating presentation, logic and data. This model permits high flexibility, enables customization, and extensions as well as the adoption of new devices or technologies. The goal of this layer is to offer transparent access to a CarambaSpace. The TAL utilizes various services to transform, describe, manipulate and observe objects. All objects managed through a CarambaSpace are well described using a meta model description framework. Objects can be customized in their structure (e.g. adding columns to tables, adding relations to objects) and their presentation by adopting their meta model description. Any changes are dynamically reflected by client components. Based on the meta model description framework Caramba enables various options to customize data and content and to integrate data from different resources (e.g. corporate databases). This layer also provides facilities for fine-grained object notification services and the implementation of customized services based on object observers. The middleware does not manage states and persistence of objects. Objects are stored, manipulated, and retrieved via the **Persistence Layer** (PEL). Caramba leverages and adopts standard Java based technologies (e.g. JDBC, JNDI, HTTP, etc.) to access and integrate data.

5 Conclusions

This paper outlines the requirements to reconcile knowledge management and workflow management systems in order to provide business process awareness to knowledge artifacts. The Activity-based Knowledge Management approach presented here enables knowledge workers to link knowledge artifacts such as documents (format independent) or database entries to activities performed by human actors. These hyperlinks between artifacts and process activities enacted by people is currently not implemented by traditional Knowledge Management systems. We believe that the Activity-based approach to Knowledge Management provides a solid foundation for reconciliation of Knowledge Management and Workflow Management Systems. In this paper we argue that activities performed by persons need to be linked to knowledge artifacts in order to provide process awareness and –support to KM systems. A software architecture and implementation is presented in order to show the viability of our concepts.

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