COLLABORATIVE WORKFLOW IN DISTRIBUTED TEAMS – MANAGEMENT AND IMPLEMENTATION ISSUES

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ABSTRACT

Organizations are increasingly forced to manage and coordinate their product and service development processes, to make their products and services available as quickly as possible, and to involve employees, customers, suppliers, and partners in different stages of the processes. To accomplish this, organizations focus on coordination across their distributed teams. One of the fundamental problems IT-Management has to deal with in this regard is the lack of continuous business process support for distributed teams across a variety of corporate information systems: from electronic brainstorming tools up to collaborative workflow management systems (WfMS) for enactment of business processes activities. The contribution of this paper is the development of a framework to identify management and organizational variables relevant to collaborative workflow management systems for distributed teams and to provide IT-management with the required understanding to implement collaborative workflow systems successfully.

INTRODUCTION

The interdependences among Information Technology (IT) Management and information assets have never been greater than in the area of the networked global economy. Efficient use of technology and communications-infrastructure are key factors to the success and viability of modern and flexible organizations. Organizations increasingly manage and coordinate their product and service development processes, to make their products and services available as quickly as possible, and to involve employees, customers, suppliers and partners in different stages of their business processes. To accomplish this, organizations are increasingly more focused on coordination issues across departments, cultures, project groups, applications, customers, partners, suppliers, distributors, retailers, and employees. One of the fundamental problems IT-Management has to deal with in this regard is the lack of continuous business process support across a variety of corporate information systems.

Information Technology in general and business process modeling tools, Workflow Management Systems (WfMS) (e.g. Bussler 1999), and Groupware (Ellis and Nutt 1980) systems in particular have been used to automate or to augment business processes in organizations (Bussler 2001; Schal 1996). Groupware has been defined as "technology based systems that support groups of participants working on a common task or goal, and that help provide a shared environment" (Ellis et al. 1991). It naturally includes technologies such as electronic mail, video conferencing, and shared group document editors. Groupware typically does not contain any knowledge or representation of goals or processes of the group, and thus cannot explicitly help to forward the group process. Groupware systems are not organizationally aware. On the other hand, workflow systems are typically organizationally aware because they contain an explicit representation of organizational structure and processes. 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 1995). Whereas Groupware has been criticized because it is not organizationally aware, WfMS have been criticized because of its typically inflexible and dictatorial nature compared to the way that office workers really perform tasks (Grudin 1988). Future WfMS will cover inter-organizational activities and processes including product value-chains on the Internet (Bussler 2001; Casati et al. 2001; Chen et al. 2001; Christophides et al. 2001; Kafeza et al. 2001; Krithivisan and Helal 2001; Papazoglou and Jeusfeld 1998; Puustjärvi and Laine 2001; Zeng et al. 2001). With this in mind, management and implementation issues regarding collaborative WfMS for distributed teams will naturally become even more relevant.

In recent years there has been considerable attempts to merge workflow and groupware technologies. Industrial research labs and product teams have made significant steps forward (Chen et al. 2001; Hausleitner and Dustdar 1999). While most successful commercial WfMS have been developed in the United States, it is interesting to note that

most academic research on the subject has been conducted in Europe. This might reflect a tendency of "low-context" cultures (O'Hara-Devereaux and Johansen 1994) to plan, control, and monitor the information flow of business processes.

A WfMS can impose a rigid work environment on users, which often has consequences. One example is among users who perform time-consuming manual "work arounds": the consequence is lower efficiency and dissatisfaction with the system. Therefore, for distributed teams it is of paramount importance to provide a less rigid workflow; one in which the users can, within limits, define the flow of work. Workflow automation provides unique opportunities for directing 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.

Generally speaking, *business processes* have well defined inputs and outputs and serve 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 1995). 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 1995). 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 (staff-assignment), generating work lists for individuals, and routing tasks and their associated objects such as documents between the agents.

Recent advances in the area of Internet Computing and collaborative WfMS are often seen as essential for supporting distributed, often cross-cultural, teams. Workflow systems generally aim at helping organizations' team members to communicate, coordinate, and collaborate effectively as well as efficiently. Therefore WfMS possess temporal aspects such as activity sequencing, deadlines, routing conditions, and schedules (Chinn and Madey 2000). In other words, collaborative process coordination systems such as WfMS inherently are related with "cultural" issues such as peoples' attitude towards time and people (Dustdar and Hofstede 1999). Cooperative tasks in distributed teams are increasing and as a consequence, the use of collaborative systems is becoming more pervasive. WfMS and project management systems are prototypical for this need in organizations. Knowledge work requires the interaction of many individuals, groups, and project teams. It is recognized that information systems supporting collaborative business processes (e.g. where teams collaborate on various sets of tasks) require some sort of "cultural awareness" to succeed in cross-cultural teams (O'Hara-Devereaux and Johansen 1994).

To fully understand the context of collaborative WfMS it is important to first analyze the dimensions of current systems. In this paper we analyze process supporting systems along two orthogonal dimensions: task automation and process structure as shown in Figure 1 (Dayal et al. 2001). Tasks in business processes are performed automatically by an application (application centric tasks) or by involving human judgement or manual processing in general (human centric tasks). Business processes may have different levels of structure. A process is highly structured when business rules and sequences that tasks have to follow are predetermined and pre-modeled. In a semi-structured process only parts of the rules are pre-modeled. Other parts of the rules may be modified on the fly (ad hoc process). In an unstructured business process no repeatable patterns of rules or any sequences among the tasks exist. Unstructured processes are often performed by participants when they meet at the same time. In the upper right corner business process modeling systems, production WfMS, and Enterprise Application Integration (EAI) Systems are to be found. This space is called Design center for Process Management Systems (Dayal et al. 2001). In this paper our focus is on integration aspects of collaborative WfMS, therefore this paper concentrates on the design center for computer-assisted collaboration systems, which involves human-centric tasks and unstructured and semi-structured processes mainly found in distributed teamwork.

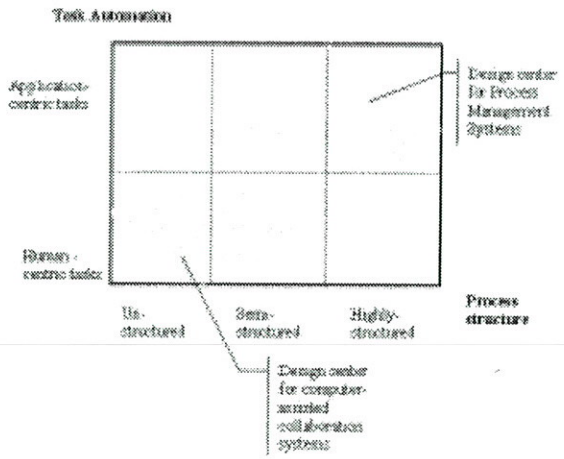

Figure 1: A two-dimensional framework for WfMS

Figure 2 illustrates a high-level process map of "New Product Development" (NPD), a collaborative business process common in most product companies. On the left side are the functional departments or skill sets that have to be applied to various NPD tasks. The business process map itself portrays the manner in which tasks relate to one another through time, as the product moves from concept to development, to manufacturing, and then to distribution. This NPD example is a typical collaborative workflow: it requires the interaction of diverse skill sets usually found in cross-departmental structure and in most cases many cultures (organizational cultures such as Marketing and Engineering, as well as national cultures as it is often the case with manufacturing and distribution partners located in different countries) are involved throughout this processes.

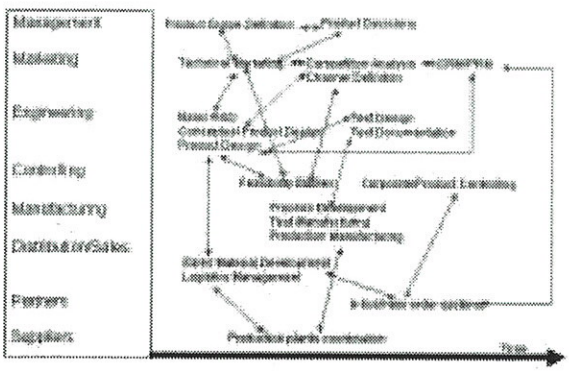

Figure 2: "New Product Development" - a collaborative Workflow

This paper argues that IT-Management, researchers and practitioners alike, should be aware of qualities of collaborative WfMS they implement and relate those to management and implementation variables in order to efficiently and effectively utilize systems and in order to provide transparent support for distributed team work.

The reminder of the paper is structured as follows: Section 2 investigates characteristics of business processes, tasks, and teams. Section 3 introduces the enactment theory framework for analyzing the phases, steps, and software supporting business processes. Section 4 discusses some fundamental requirements for continuous support for collaborative business processes as elaborated in the enactment theory framework. Finally the concluding section discusses implications for IT-Management and future work.

CHARACTERISTICS OF PROCESSES, TASKS, AND TEAMS

Before we analyze teams and their usage of business process systems we need to take a look at some of the characteristics of self-managed teams and review some of the critical success factors for work teams. Those factors include (Mintzberg 1979):

1) an organizational culture which facilitates team-building and collegiality;
2) clear aims and objectives for the team in the context of the larger organization;
3) a strong commitment to the team by individual members;
4) frank and open communications to promote constructive criticism among team members;
5) a reward system which encourages creativity, innovation and risk taking.

Collaborative WfMS substantially support and enable those critical success factors for teams. For example clear goals and objectives are required to model tasks as part of business processes. Research shows that team performance is positively affected by communications between team members, as shown in (Mc Donough et al. 1999). Literature stresses the importance of the formal and informal communicative aspects of WfMS, which reflect the underlying structural dependencies in work settings (Chinn and Madey 2000; Mc Donough et al. 1999; Flores et al. 1988). Working in organizations is often characterized as "networks of commitments", as people in the organization send work through the systems (Winograd and Flores 1986). In this context it is important to note, that with business process reengineering, activity based costing, and total quality management challenging the traditional division into separate functional departments, and their associated task support systems, such as negotiation support systems, project management systems, decision support systems, and WfMS, a need for integrative systems arises to span the whole task/process continuum (e.g. Craven and Mahling 1995). Mintzberg (1979) listed five fundamental ways of coordinating tasks in an organization:

1) Mutual adjustment
2) Direct supervision

3) Standardization of output
4) Standardization of work processes
5) Standardization of skills

Collaborative WfMS aim at supporting mutual adjustment (coordination), standardization of output (modeled tasks and the associated applications to perform tasks), and the standardization of work processes (modeling of business processes).

Tasks in organizations have a purpose. Both projects and workflows have explicit and implicit goals. The explicit goal of a project is its objective or final product, such as a software product or a service. Implicit goals include successful achievement of explicit goals and possibly include personal goals as well. Enhancing the efficiency and effectiveness of office work is an example for an implicit goal (Ellis and Nutt 1980). Workflow systems use tasks on the lowest level called executable steps in process engineering. Sets of sequential or parallel steps form a business process. Processes can be linked to form process chains. Projects on the other hand are per definition unique and can be decomposed into sub-projects (often called activities) but eventually executable steps must be performed to bring the project to completion. To summarize: A workflow process such as ordering of a product could be decomposed into the tasks of checking the inventory, evaluating the customer, approval, shipping, and billing. Hence, as there are process hierarchies, activities, and steps within tasks, each of these has corresponding goals.

ENACTMENT THEORY FRAMEWORK

This paper suggests an enactment theory approach to the study and design of collaborative WfMS that entails different phases, steps, and maps current software product categories to them. Enactment theory (Mahling 1993) operates at a higher level of abstraction than either speech act theory (Winograd and Flores 1986) or planning theory (Mahling 1993). The interesting work and products of Winograd and Flores based upon speech act theory suggest that any interaction can be viewed as a "conversation" with a protocol structure that can be modeled as a workflow (Winograd and Flores 1986). The coordinator was a product emerging from this work that had this protocol notion built in.

In enactment theory, the enactment is considered the basic building block of human activity (Mahling 1993). Persons and their context are connected via enactments. In acting, people affect their context, yet simultaneously comply with contextual constraints. In short, enactments are processes of behavioral patterns meant to purposefully transform states of reality incrementally in the direction of a goal (Mahling 1993). The enactment process as depicted in Figure 3, has different phases consisting of steps. It is crucial for IT-Management to be aware that software products such as brainstorming tools, project management tools, or WfMS aim at different phases and steps of the enactment of business processes. This awareness is important for several reasons: When business processes are enacted they pass through different phases and steps. Each of those steps requires different tools for their support.

Management of Engineering teams, for example, focus on "Engineering" sub processes (see Figure 2). When results of their tasks are passed onwards to the next process step, the context of the Engineering work gets lost, due to the use of a different software system. A common example of this dilemma is the conflict between Engineering (R&D) and Marketing (see Figure 2). When engineering work is finished and the results are passed to Marketing for creating marketing material for the product, the marketing department does not have access to the knowledge and context of Engineering. Marketing might produce collateral, which the Engineering departments are not satisfied with. This might result in conflicts between those departments. Currently each of the enactment steps utilizes their specific software tools. It remains a challenge for IT-management to "glue" those systems together in order to provide a collaborative business process support in all process stages. Collaborative WfMS have the goal of providing support for all steps in business process enactment. The following paragraphs explain the enactment phases as depicted in Figure 3 in detail.

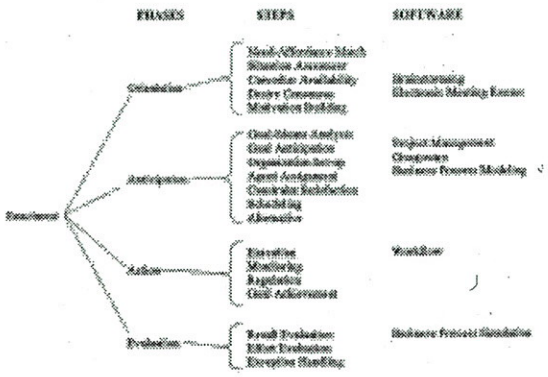

Figure 3: Enactment theory framework

The **orientation phase** comprises steps such as matching the needs to affordances (goal refinements) and building motivation. For those steps software systems used in Electronic Meeting Rooms, such as systems supporting the brainstorming process may be utilized. The **anticipation phase** builds on the motivation developed before and includes steps such as setting up the organization, assigning agents (people) with tasks, and scheduling tasks. The **action phase** consists of the actual execution steps of the tasks necessary for achieving the goals as well as monitoring their success. During those steps collaborative WfMS

software may be used. Finally, in the **evaluation phase** results, efforts, and exceptions are evaluated. Business Process Simulation software is a companion technology during this phase.

Currently software systems supporting the integrated and continuous enactment of business processes as a whole (as depicted in Figure 3) do not exist. The requirements raise a number of research questions typical for the area of Computer Supported Cooperative Work (CSCW). Some of the design issues of the architecture of collaborative WfMS are:

- Supporting collaborative definition of tasks and their mapping to goals and business processes
- Supporting sharing of artifacts (objects and resources) in all phases and steps of business processes
- Monitoring the distributed execution of steps

COLLABORATIVE WFMS REQUIREMENTS

This section seeks to clarify the requirements for software systems supporting the full enactment cycle as depicted in Figure 3. To better understand the implications for a continuous enactment support, we will provide examples of software usage during the respective phases with the goal to specify some requirements for integrating the systems discussed.

In the "*Orientation*" phase the main driving force is the desire to build consensus on the availability of resources and regarding motivational issues. Figure 4 shows one example of an electronic meeting room, where this phase is supported by software and hardware. Following the idea presented in Figure 3, it is one goal of the orientation phase to specify the requirements of the project under discussion. Ideally, these requirements and the artifacts created during this phase, will be stored in a repository accessable for distributed team members. A repository provides a persistence store for artifacts, such as text-documents, multimedia files (audio, video) taken from the meeting itself, and the communications flow (questions, answers, reasons) of the team members.

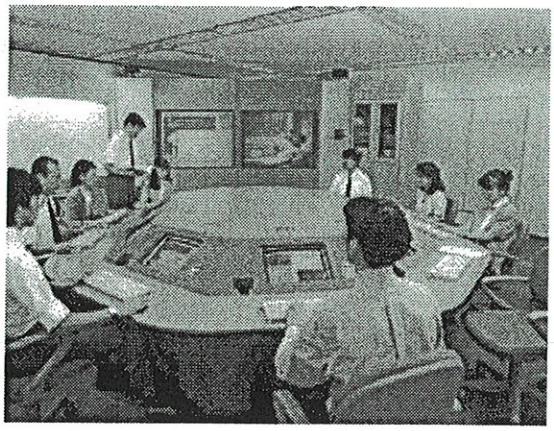

Figure 4: NTT Electronic Meeting Room (InterPOD)

The "*Anticipation*" phase focuses mainly on organizational-setup for the projects. Most frequently tools for project management are used for this purpose. The artifacts created with tools in this phase comprise project plans, resource plans, and work breakdown structures. Project management systems focus mainly on a view for the project manager. They seldom provide support for different "views" on a project (e.g. depending on the team members' role) and also provide no support for enactment (execution) of project plans, as required in the next (Action) phase or simulation as required in the "Evaluation" phase of the enactment lifecycle.

The "*Action*" phase is mainly concerned with the actual project dynamics, the instances of projects. In most cases (collaborative) workflow management systems are used to first model the required activities of a project and then to enact the model. Collaborative WfMS provide software support for the execution of the modeled activities. Therefore it is possible (e.g. for project/process managers) to analyze any instance of a process (project). This means that the information and communications flow of the participants may be monitored and traced. Figure 5 depicts a model of a simple directed workflow graph, which is enacted during a software development project.

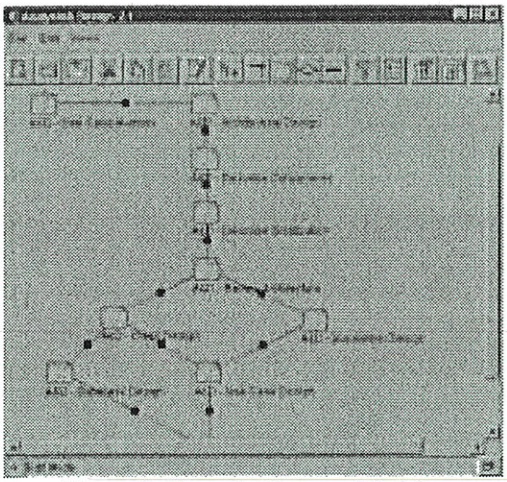

Figure 5: Caramba Process Modeler

Finally the "*Evaluation*" phase is concerned with the overall evaluation of the project or process flow itself. The main questions one is interested in this phase are: Did we reach our goals? Are we on time and within our budget constraints? What would happen if we would enact this project differently (e.g. through simulation of alternative process models based on various criteria)?

CONCLUSION

This paper presented a two dimensional framework for collaborative technologies enacting business processes for distributed teamwork. Based on current software systems in those categories, we presented a theoretical enactment framework, elaborated the requirements, and discussed the current shortcomings of software systems required to fully support the enactment framework "life-cycle". Our future work will comprise detailed analysis of systems interfaces between electronic brainstorming tools, project management systems, business process modeling systems, collaborative workflow management systems, and process simulation systems. Further research is also needed on how collaborative workflow systems can be designed, not only to execute the logic of a workflow, but also to satisfy human, cultural, and organizational needs.

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