A FRAMEWORK FOR SUPPORTING KNOWLEDGE WORK PROCESSES

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Abstract: Improving knowledge work processes has become increasingly important for modern enterprises to maintain a competitive status in nowadays information society. This paper will propose a way to improve knowledge work processes through supportive services. A framework for supporting knowledge work processes will be presented where the best practices of knowledge work processes, developed by process organizers or derived from some successful applications, are described and stored in a database, and according to the description, software agents dynamically organize supportive services to guide process participants to advance process steps towards the efficient completion of a process. The paper will provide an overview of the method and explore the development of the main components in the framework.

1 INTRODUCTION

With the shift from an industrial economy to a knowledge based economy, improving knowledge work processes has become increasingly important in modern enterprises for providing competitive advantage and sustaining their success (Drucker, 1999). Knowledge work processes are knowledge-intensive business processes, where the dominant process activities involve abstract reasoning, problem-solving and decision-making. Examples include market research and development, strategic planning, new product development, etc. To achieve a quality outcome, most such processes require their participants to have sufficient information, specialist knowledge and experience and also require them to mutually collaborate and cooperate as well. Currently participants have to carry out considerable amount of manual work to search, assemble and organize various required information and develop contacts to achieve an outcome.

Searching ways to organize knowledge work processes with minimal manual work and lowest cost has attracted many research efforts. The problem is that most of them have been focused only on information management (Röll, 2004). Very little has been done to improve the entire process. There is no integration of technologies to support the different dimensions of a knowledge work process. The ways for how to facilitate the completion of a knowledge work process with higher efficiency and lower cost are still lacking to date.

In this paper we will propose a way to improve knowledge work processes through providing supportive services for participating actors. A framework for supporting knowledge work processes will be presented. A work process specification language (WPSL) will be developed to describe best practices of knowledge work processes, developed by process organizers or derived from some successful applications. A multi-agent architecture will be developed to guide participants to advance process steps. The software agents in the architecture will, according to the knowledge captured from the description of the best practices, organize and provide services for participants to facilitate process completion with higher efficiency and lower cost. The paper is organized as follows. Section 2 provides a general description of a knowledge work process. Section 3 presents our research strategies to improve knowledge work processes, where a framework for supporting knowledge work processes is proposed. Section 4 deals with the implementation of workspaces. Section 5 explores the development of the database storing best practices of knowledge work processes,

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described by using the WPSL. Section 6 addresses the development of software agents realizing the supportive services. Finally, section 7 summarizes the paper with an outlook on the further work.

2 GENERAL DESCRIPTION OF A KNOWLEDGE WORK PROCESS

Knowledge work processes are a category of business processes. A business process involves many different dimensions and hence, there are various possible ways to classify business processes. Figure 1 shows a classification of business processes by the process complexity dimension and the knowledge intensity dimension (Mertins *et al.*, 2001). It maps business processes into four classes. Examples for each class are respectively put into its corresponding quadrant. Our research is aimed to support the business processes that are mapped into the right part of the figure and in particular the ones in the third quadrant.

Knowledge work processes not only include structured process routines but also include various knowledge-intensive activities, such as reasoning, problem-solving, decision-making, etc. In doing these knowledge-intensive activities, knowledge workers access data, use knowledge, employ mental models, and apply significant concentration and attention (Davis, 2002). Obviously knowledge work has distinctive characteristics, which differ from administrative, operational work, or other structured work. The typical ones can be summarized as follows: 1) it requires participants to possess a high level of skill and expertise; 2) it often involves distributed work and requires group efforts to

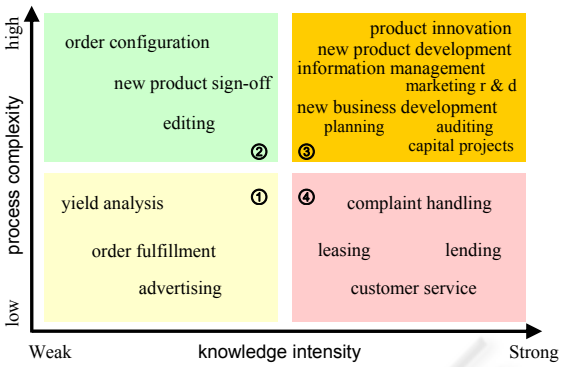

Figure 1: A classification of business processes.

accomplish; 3) there are no predicted task structures and sequences and their evolution may be influenced by the outcomes of the earlier stage; and 4) there are no standard solutions and they may vary somewhat based on the actor doing the work. To characterize these characteristics in combination, *emergent* might be a good label (Markus *et al.*, 2002).

Figure 2 provides a general description for a knowledge work process (Hawryszkiewycz, 2006). It can describe many concrete processes in modern enterprises, such as improving the quality of a product in a company, for example. In such a process, a situation is identified at first, for example by receiving feedback from customers on the product quality. Then the situation is assessed and alternate courses of action are then determined based on the assessment and other knowledge relevant to the product and the company. A suitable course of action is chosen from them. The relevant execution plan is designed and then that course of action is executed. These process steps are performed by different actors who may work at different places.

As seen from Figure 2, an actor, to take his/her role, not only needs knowledge and experience for

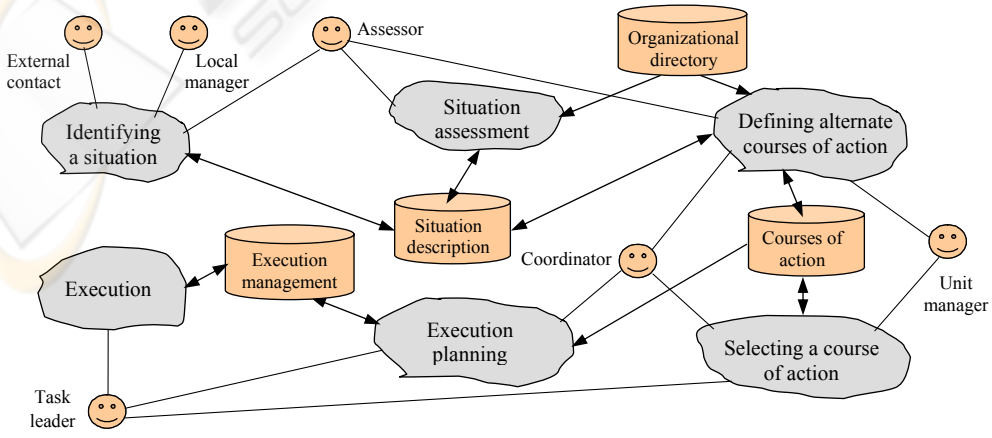

Figure 2: A general description of a knowledge work process.

his/her own responsibility but also requires information pertaining to other actor's work and cooperation with other actors for a common goal. This paper suggests software agents be integrated into the work environment to help them get such information and guide them to get through process steps. In the following sections, the description of a knowledge work process will be used as a basis for our research to improve knowledge work processes.

3 AN AGENT BASED WAY TO IMPROVE KNOWLEDGE WORK PROCESSES

The research presented in this paper aims to develop supportive services to improve knowledge work processes toward best practices based on the cost-effectiveness principles. It will develop a structure like that shown in Figure 3 to *assist* participants working across distances to conduct process activities and *facilitate* process completion with higher efficiency and lower cost. More specifically,

- It will develop electronic workspaces for participants to conduct process activities, exchange knowledge and information. A wide range of supportive tools, including knowledge mining tools, information visualization tools, communication and collaboration tools, will be seamlessly integrated with the workspaces to help the participants capture and annotate information, make sense of information, reflect, get feedback, share, discuss and cooperate with others across distances (Röll, 2004). The supportive services for facilitating process completion will be provided for the participants also through the workspaces.
- It will develop a database, *process guide database*, to store various "*best*" approaches to performing a knowledge work process. Following them, participants may capture best practices in accomplishing the process. To develop such a database, it is required to analyze and examine knowledge work processes to structure process activities and build a metamodel of "*best*" progression by using related theories. Moreover, it is required to describe the metamodel in a formal way. Using the knowledge captured from the description stored in the database, agents will guide different actors in Figure 2 to advance process steps towards an efficient completion of the knowledge work process.
- It will develop a multi-agent architecture to *actively* organize and provide services for participants in the given situations. The agents will work at the background, observe and monitor the events that happen in the workspaces, and based on the actual progression at execution-time, enact process activities, manage them, and provide supportive services to facilitate their efficient completion, by using the knowledge captured from the *process guide database*. All the services will be customized to individual participants based on their particular needs.

In short, our framework mainly includes three components: 1) the electronic workspaces for conducting process activities, 2) the process guide database storing best practices, and 3) the multi-agent architecture realizing supportive services according to the best practices stored in the database. In the following sections, we will respectively explore the development of these components.

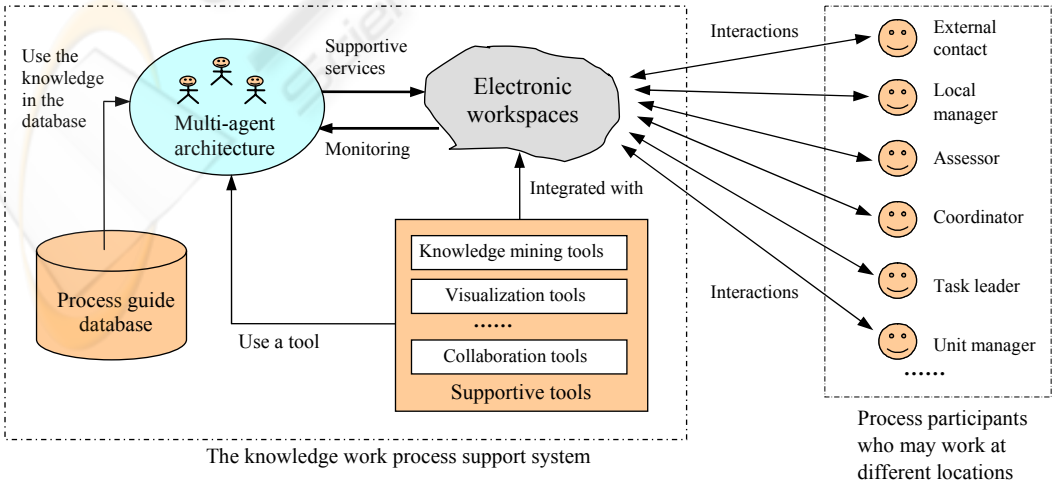

Figure 3: Overall architectural framework for supporting knowledge work processes.

4 DEVELOPMENT OF THE WORKSPACES

Since knowledge and information for a knowledge work process is typically distributed over different locations, participants require knowledge sharing to achieve an outcome (Markus *et al.*, 2002). It is thus necessary to provide a space over the Internet for them to carry out relevant process activities and implement required collaboration and knowledge sharing. Electronic workspaces are such a shared mental space implemented by advanced ICT, where participants can not only exchange views and ideas but also share feelings, emotions, experiences, and other mental models. On the workspaces, they can work individually, and if necessary, they can work collaboratively with others towards a common goal. They are given varied flexible and convenient means to support various process activities.

The electronic workspace shown in Figure 3 can be implemented by our *LiveNet* system (Hawryszkiewycz, 2005), developed based on the requirements for supporting collaborative process processing. It supports both synchronous and asynchronous collaboration of distributed groups of participants through utilizing workspaces as the commonly shared place. By *LiveNet* workspaces, participating actors, no matter where they are, are able to share information with one another in their own workstation, for example, they can use a same document or discuss a same issue. They can exchange messages one another by text or graphic images. Also, it provides a diversity of technological facilities and means for facilitating process progression through workspaces.

In *LiveNet*, any number of roles can be defined for a workspace, and users can be added to a workspace as participants taking roles. One user can have different roles in different workspaces, but can only occupy one role in each workspace.

LiveNet provides the flexibility to set up workspaces and supports their dynamic evolution as the process emerges. An example is shown in Figure 4, which illustrates workspace evolution in a process for *improving the quality of a product* in a company. As depicted in the left screenshot of the figure, the workspace named as *improving product quality* contains two projects (sub workspaces) and three artifacts, five roles have been defined for the workspace, and four users have participated in activities within the workspace. The right screenshot shows the workspace after the process progresses. It can be seen from the screenshot that four artifacts have been added to the workspace.

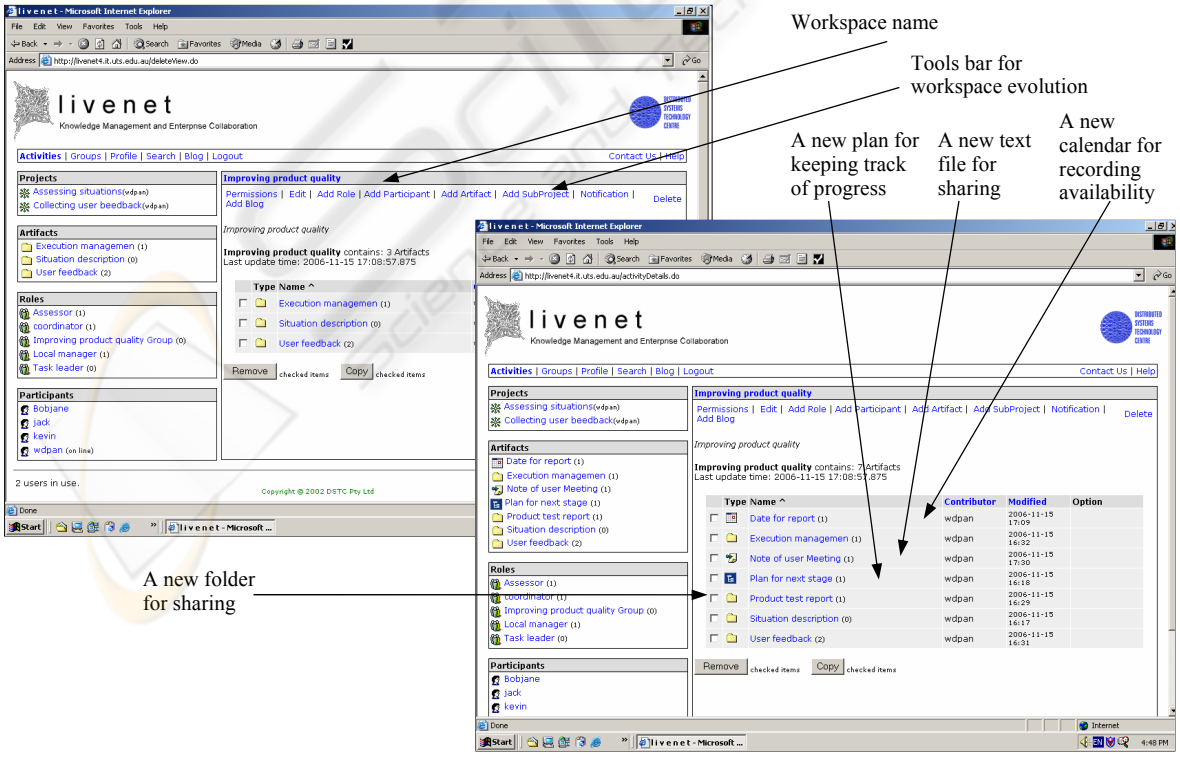

Figure 4: Progression of workspaces in a knowledge work process.

5 DEVELOPMENT OF THE PROCESS GUIDE DATABASE

To guide participants to advance process steps in knowledge work processes towards an efficient completion by using the structure shown in Figure 3, a principal challenge is to provide knowledge for software agents so that they can support all the different activities shown in Figure 2. It is thus required to explore ways to evolving process steps towards the attainment of the greatest process productivity and lowest cost, and develop a formal way to describe these ways. A *work process specification language (WPSL)* is thus necessary to describe knowledge work processes.

Building upon our earlier work on facilitating learning processes (Pan & Hawryszkiewycz, 2006a) and a hypothesis that a knowledge work process can be described and facilitated in a similar way as a learning process, we have designed a WPSL for specifying knowledge work processes (Pan & Hawryszkiewycz, 2006b). Consequently the best practices of knowledge work processes, developed by process organizers or derived from some successful applications, can be described using the WPSL in a formal way and stored in a process guide database. This section will investigate into the development of the database.

5.1 Requirements for the Database

The purpose for developing the *process guide database* is to store ways to evolving process steps in a knowledge work process so that agents can capture knowledge for supporting process activities and providing guidance for individual participants to facilitate the completion of process activities in a robust way. As shown in Figure 5, the database provides links between a real working scene and the corresponding service for the actors doing the work. Using the links, agents will offer suggestions regarding *bes*t ways to carry out the current activities that can be followed by different actors in Figure 2. Hence, the database must provide a formal way to describe various process activities and their execution at a level of abstraction above the specific instance of the content in which it is created.

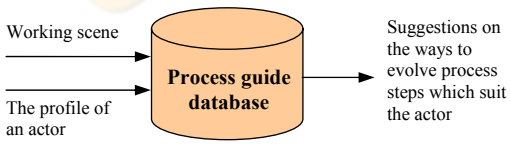

Figure 5: Role of the process guide database.

5.2 Composition of the Database

In our research, a knowledge work process is considered as a composition of a series of smaller components, *a unit of work (UOW)*. A UOW is referred to any delimited piece of process activities in enterprises, such as writing a report, making a decision, designing a plan, etc.

A UOW is described using the WPSL we have designed (Pan & Hawryszkiewycz, 2006b). The activities of the UOW, their sequences, and the relevant services for supporting these activities are described through a particular architecture, which includes the following six elements:

- *Metadata* that specifies commonly used entities within the UOW, including its *ID*, *Work goals*, and *Preconditions*;
- *Role* that illustrates various actors who may participate in performing the UOW, for example the ones shown in Figure 2;
- *Service* that describes all the supportive services that may be provided for actors to support and facilitate the completion of the UOW*;*
- *Content* that describes all the activities involved in the UOW, each of which respectively illustrates the type of the activity, what it does, its outcomes and the corresponding services for supporting the activity;
- *Method* that specifies all the possible methods to evolve activity steps within the UOW; and
- *Work plan* that declares the links between a method and its targeted actor's category.

All these are compound elements and each contains a set of more elementary elements. Some are optional, and some may occur many times.

A UOW record describes the practices to evolve the UOW by such a complex architecture. In this way, the *bes*t practices of a knowledge work process can be described by a series of such UOW records, constructing the *process guide database* in Figure 3.

6 DEVELOPMENT OF THE MULTI-AGENT ARCHITECTURE TO REALIZE THE SUPPORTIVE SERVICES

It can be seen from Figure 3 that the development of the multi-agent architecture is another challenge to improve knowledge work processes. The multi-

agent architecture is to realize the services that support knowledge work processes. It will be developed by extending the agent systems that support business process management. Agents have already been introduced into business process management (Jennings *et al.*, 1998). The problem is most current systems focus only on enhancing well-structured business processes where all the logical paths can be defined *in advanced*. They pay little attention to emergent knowledge work processes. This research suggests agents be integrated with the knowledge work processes to provide services that not only assist participants to conduct structured process routines but also facilitate the completion of knowledge-intensive work, for example assisting participating actors to identify a situation, assess situations or define alternate courses of action, as shown in Figure 2. It places a strong emphasis on the guide for various knowledge-intensive activities.

The agents in the multi-agent architecture will be designed to guide participants to advance process steps based on the knowledge gained from the *process guide database* and the actual process progression. They will work at the background, monitor the workspaces. When an event is detected, they will use a *Belief-Desire-Intention* based proactive reasoning to decide actions to respond the event (Jennings *et al.*, 1998). They will provide supportive services for participants based on actual work scene. For example, when the execution of a process activity is being detected by the agents, they will provide services to

- assist the actors to search, annotate, and make sense of information required for the execution of the activity;
- foster knowledge sharing among the actors while performing the tasks specified in the activity;
- encourage and scaffold the actors to actively engage in the efforts for reasoning, problem-solving, and decision-making using his or her own personal preferred ways while taking a responsibility in the activity;
- aid the actors to timely and accurately evaluate outcomes of the activity.

A critical work for developing such a multi-agent architecture is the development of the *briefs*, *intentions* and *reasoning strategies* for the involved agents so that they can collaboratively work for the participating actors and provide them with right services at right time to facilitate efficient completion of the process.

7 OUTLOOK

The paper has presented an architectural framework for supporting knowledge work processes and an overall description on how the involved components will be developed. The framework is currently under development. It is hoped that the implementation of the framework will enable

- process organizers to specify process activities and recommend accomplishment strategies for the participating actors by using the WPSL;
- process participants to get effective guide provided by software agents. The guidance will not only help them advance process steps but also facilitate the increase of productivity and the decrease of required costs;
- enterprises to get benefits from the improvement of knowledge work processes.

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