Applying Topic Maps to Ad Hoc Workflows for Semantic Associative Navigation in Process Networks

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Abstract

The increasing integration of groupware-based office systems in the internal business processes of companies leads to growing information memories. A significant part of work in such an office environment involves a combination of highly structured processes and tasks where the process is fuzzy and the rules, routes, and roles are dynamically defined as the work is being done (ad hoc processes). Until now, this type of processes has been viewed as not worthwhile to be supported by specific tools or systems. The GroupProcess project postulates the need for an effective support of ad hoc workflows in groupware-based office environments. An inherent challenge in this project is the analysis of a great amount of already run workflows. As a solution we chose topic maps to identify distributed knowledge structures in a process-oriented groupware environment. Topic maps provide mechanisms for navigating and linking, as well as options for extensive searches and investigations to explore and to use the complex information and knowledge offer. The usage of topic maps addresses the challenge of analyzing run ad hoc workflows. Furthermore, applying topic maps to workflows in general enables the identification of the implicit and inherent process knowledge.

1 Introduction and overview

In the middle of the 1990s great efforts were made to develop concepts and tools for the workflow implementation of structured business processes in companies and other organizations. But a sustainable part of work in an office environment involves a combination of highly structured processes and tasks where the process is fuzzy and the rules, routes, and roles are dynamically defined as the work is being done (ad hoc processes). Until now, this type of processes has been underestimated in recent years. Until now, this type of processes has been viewed as not worthwhile or not possible to be supported by specific tools or systems. This may be a reason why current workflow management systems are not as successful as expected and are deemed to be “too rigid”. Together with the components for less structured processes that provide “soft” interaction, a system arises that covers a greater portion of the existing processes in a business environment. In our opinion communication systems like e-mail on the one hand and coordination systems like workflow management systems (WFMS) on the other hand should grow together. Thus, there should firstly be a particular support of ad hoc workflows. Additionally, there should be a linkage between WFMS and the support of ad hoc workflows to gain synergetic advantages of both system types. The GroupProcess system offers this support of ad hoc workflows as well as a linkage to an existing document-oriented workflow management system.

In many companies groupware environments are the basis of communication and information management. The increasing integration in the internal business processes leads to growing information memories. These in groupware-based office systems often existing shared databases enable to transform the individual knowledge of one employee into a common knowledge of all employees ([1], p. 3). The exploding amount of available knowledge requires powerful concepts and mechanisms to support users who search for relevant information and knowledge objects. Mechanisms for navigating and linking, as well as options for extensive searches and investigations are needed to explore and to use the complex information and knowledge offer. They are a necessary condition for the core processes of knowledge identification and knowledge use [2]. Therefore effective search mechanisms, which provide an improved organizational use of existing individual and collective information and knowledge objects, contribute to the process of knowledge generation (the development or collection of new knowledge) ([3], p.248). Additional to the existing techniques in groupware-based office systems for searching and navigating, like the hierarchical navigation in categories of views or full text searching, applying topic maps to groupware-based information and knowledge base
provides the user with the strong concept of associative navigation in semantic networks.

The GroupProcess project postulates the need for an effective support of ad hoc workflows in groupware-based office environments [4]. An inherent challenge in this project is the analysis of a great amount of already run workflows. The use of topic maps as a solution for the identification of distributed knowledge structures in a process-oriented groupware environment is described in [5]. Our main emphasis is to address the challenge of analyzing ad hoc workflows using topic maps. In addition, applying topic maps to workflows in general enables the identification of the implicit and inherent process knowledge.

In recent years a simple tool for the management of ad hoc workflows has been used at the GCC (Groupware Competence Center, University of Paderborn, Germany). Although this tool does have some limitations, over 4000 ad hoc workflows have been executed over the past 5 years. So far, there is no adequate technique available to visualize these processes. This example shows the need for concepts and tools like those described in this paper.

To form a base for the main part of our paper, we briefly introduce the GroupProcess project to present our concept of ad hoc workflow management in chapter 2. The following chapter describes an approach for the ex post analysis of ad hoc workflows utilizing topic maps. Chapter 4 outlines concluding remarks and the current state of the project.

2 GroupProcess: Participatory and evolutionary design of ad hoc workflows

The subsequent paragraph summarizes the objectives and concepts of the GroupProcess project followed by a delimitation of GroupProcess within the field of computer supported cooperative work (CSCW). A more detailed and comprehensive view into the GroupProcess project can be found in [4].

2.1 Overview and objectives of the GroupProcess project

The basic objective of the GroupProcess project is to provide a system for the management of ad hoc workflows in office and administrative environments, to enhance the efficiency of ad hoc processes. This basic objective implies several sub-goals that result from the nature of ad hoc processes and the given environment. Ad hoc processes are spontaneous, usually not planned beforehand, and often only partially predetermined. Thus, the structure develops during the execution of the process or workflow. A system to support this type of workflows should therefore be able to reflect this structure.

The knowledge about the whole process is often split between several people. Hence, every involved person should be able to dynamically add their specific knowledge to the workflow by participating in the design. As a result of this participatory design an entire workflow evolves from the expertise of the persons concerned.

An important aspect of the project is to provide an intuitive user interface that enables even non-specialists to design and execute ad hoc workflows. Besides the user interface and process visualization should be integrated in the usual work environment unlike the external workflow modeling tools of traditional workflow management systems. Fig. 1 shows a screenshot of the current modeling tool of the GroupProcess system which is integrated into a groupware-based office management environment. With this interface, process and organizational objects can be created using drag-and-drop techniques. If the pictures of the persons are available in the organizational database they can automatically be generated as a graphical user interface. The user interface contains the favorites list of core team members in a graphical representation (v. fig. 1). This list is used to choose performers of workflow tasks.

An enhanced system for ad hoc workflows is helpful to partially automate a business process. Additionally, a model of the process can be created while executing it. Hence, for a possible next execution a workflow model will already be available. This reduces the time to execute the process and therefore increases efficiency. By supporting ad hoc workflows using such a specialized system, the formerly unused implicit knowledge of the participating people can be transformed into explicit knowledge to become available to the whole organization.
Besides, this knowledge can firstly be stored for reporting reasons and secondly to be retrieved if required to graphically display the workflows that have already been executed. This can be considered to be a part of a knowledge management strategy for the organization. This paper shows how topic maps can be used for this purpose.

As mentioned before, another goal of the GroupProcess project is the integration of the system into a currently available WFMS. We do not want to reinvent or modify the existing features of conventional WFMS because we agree that they surely are suitable for their intended environment. Some ad hoc processes that are used more than once and therefore get well tried by practical experience could turn into important and established workflows for the company. As a consequence, these should be transitioned into predefined workflows in a WFMS. By using the GroupProcess system, the stored structures and protocols of ad hoc workflows can be used as a basis to design the structured workflow. Thus not the whole workflow needs to be designed from scratch. There are only modifications necessary to transform the ad hoc process into a structured one. This way, the design of workflows becomes a team-based process that involves workflow specialists as well as the users of the workflow system. This helps to increase efficiency and acceptance of the implemented workflows within a company or organization. The tools of the approach presented in this paper can help to browse and select from workflows that have already run.

Besides, there are other emerging effects in combination with existing systems like workflow-, knowledge-, and office-management-systems, which belong to the objectives of the GroupProcess project as well. The ad hoc processes in an office environment and therefore the GroupProcess project itself can be seen as a connecting module to arbitrate between these systems. The aspect of reuse of ad hoc processes can be considered as a linkage to knowledge-management-systems, while the integration of ad hoc workflow management and management of structured, predefined processes can be viewed as a linkage to conventional WFMS. Additionally, the GroupProcess system is integrated into an existing office management environment.

### 2.2 Delimitation of GroupProcess within the field of CSCW

Three types of WFMS can be differentiated. Messaging-based Workflow Systems, Document-oriented WFMS and Production WFMS (compare with [6]). As we focus on office environments of companies and organizations, we concentrate on document-oriented WFMS. Peripherally, messaging-oriented WFMS are included in the GroupProcess approach as well. As a result of these considerations, we think that groupware technologies as a part of computer supported cooperative work (CSCW) research are the best basis for our concepts, theories and implementations.

### 3 A concept for the ex post analysis of ad hoc workflows using topic maps

By applying a topic map to the set of run workflows it is possible to identify relationships between them. The following sections describe how to apply topic maps to ad hoc workflows and how to generate a topic map from a set of ad hoc workflows. The chapter ends with a presentation of a visualization approach.

#### 3.1 Introduction to topic maps

With growing organizational knowledge bases on one side and the lack in powerful and effective mechanisms and functionalities for navigating, linking, searching and investigating on the other side, the need for enhanced access mechanisms for exploring and using the complex information and knowledge offer is getting more and more evident. To address these shortcomings, the ISO standard ISO/IEC 13250 TOPIC MAPS defines a model and architecture for the semantic structuring of link networks. By applying topic maps to large sets of heterogeneous information resources, reusable structured semantic link networks are created above those resources. Furthermore, the standard provides navigation paradigms to enable the search of knowledge structures [7].

![Figure 2. Topics, occurrences, and topic associations](image)

The key concepts of a topic map are topics, occurrences of topics, and relationships between topics (associations). Starting with a topic – a topic is a construct...
that represents a real world subject and in this sense a topic can be everything: a theme, a concept, a subject, a person, an entity, etc. (v. fig. 2). A concrete topic is an instance of a topic type. Therefore, a topic and a topic type form a class-instance relationship. At the same time a topic type is also a topic.

Topics have three kinds of characteristics: names, occurrences and roles in associations. Occurrences and roles in associations are described in detail later on. The base name of a topic is required. In addition topics can have a display name and a sort name. These concepts apply to multilingual scenarios or to the use in different geographical regions.

An occurrence is a link to one or more real information objects like a report, a comment, a video or a picture (v. fig. 2). Generally an occurrence is not part of a topic map. The link mechanism itself depends on the underlying system. For example HyTime addressing, XPointer or document links in a groupware-based system can be used as a link mechanism. To express different kinds of occurrences the standard provides the concept of occurrence roles that are topics as well.

Topic associations describe the relationships between topics (v. fig. 2). They are completely independent of the real information object and represent the essential value-add of the topic map. This concept leads to some conclusions: First, a concrete topic map can be applied to different information repositories. Seen from the other side different topic maps can be applied to one information repository and therefore, they can provide different views e.g. for different users. In addition, topic maps are interchangeable and they can be merged.

Generally, associations are not one-way relationships. They are symmetric as well as transitive and thus, they have no direction. The construct of associations types can be used to group associations and the involved topics. An association role describes the role of a topic in an association. Again, both the association types and the association roles are topics as well.

Additional, the topic map standard provides the extended concepts of scope, public subject and facets which are not described here. For a comprehensive reference refer to [7] and [8].

3.2 Applying topic maps to ad hoc workflows

Considering the workflow models and workflow instances topic types, association types and occurrence roles can be identified (v. section 3.1). And therefore, topics, topic associations and occurrences can be found.

The tasks in the workflow models form topic types, e.g. in general the analysis of a problem. The instantiation of a topic type results in a topic which is a task in a workflow instance like a concrete analysis of a given problem. The connection between tasks are considered as association types. Hence, an example for a topic association might be as follows: The concrete task “analysis of a problem” leads – because of the result of the analysis – to the concrete task “make a decision based on the analysis”. The different statuses of documents in workflow instances form occurrence roles. Thus, an occurrence is a concrete status of a specific document.

Figure 3. Navigation paths through workflow models and workflow instances

The topic map build from the workflow models and workflow instances enables the identification of similarities and relationships between them. The different workflow models and workflow instances are expressed in one topic map. Therefore, they form a structured semantic link network which enables the navigation through the workflow models and workflow instances (v. fig. 3).

3.3 Generating a topic map from a set of run ad hoc workflows

The starting point for the ex post analysis of workflows is a collection of workflow cases that have already been worked off. In the GroupProcess system all information of ad hoc workflows are stored directly in the document of the workflow case. Hence, such a document contains the structure of the workflow (“workflow definition”), the protocol of the tasks that have already been finished, and the content of the workflow case. The workflow structure and protocol is stored in XML representation in one field in the document. For the purpose of the ex post analysis of ad hoc workflows a specific translation tool is being developed: This tool transforms the XML representation of the workflow structures into fields of temporary documents which are only used for the generation of the topic map. As pointed out in [5], the basic design elements of groupware-based applications, especially fields on forms (on documents respectively), can be used to identify
the main subjects (topic types) and relationships between them (association types). The fields, which store workflow structures in this case, form a set of potential candidates for topic types. Also, looking at the temporary documents as a whole, a lot of basic associations can be found between those topic types. These information form the basis for a set of tools also described in [5], which generate a topic map (generic topic map engine) and provide functionalities to navigate and search the resulting topic map (topic map navigator).

For the realization of this approach, we suggest the architectural model represented in fig. 4. Therefore, the architecture presented in [4] is expanded with necessary modules for generation, management and navigation of topic maps (for a detailed description of these modules please refer to [5]).

3.4 Visualization approach

The combination of the basic visualization approaches described in the GroupProcess and K-Discovery projects form a suitable basis for a user interface. Fig. 5 presents an approach of a visualization.

The user interface is divided into two main parts. The left side provides capabilities for navigating and searching. This left frame contains a textual representation of the topic map which consists of a complete list of topics, topic types, association roles and topic associations.

The right side is separated into two frames to display the actual selected objects. In the upper part the workflow model corresponding to the choice made in the navigating and searching part is represented. In the lower part the occurrence, i.e. the concrete status of a specific document, is shown.

Figure 4. Architectural model

The GroupProcess workflow access module provides an object oriented class hierarchy for accessing the XML representation of the workflow structure. The methods of these classes are used to read the necessary information from the workflow documents and write it into the fields of the temporary documents. The different information which are needed for the topic map creation are read in several runs through the workflow documents. In the first step the topic types are created from all tasks that have been used in the workflow cases. In the second step the topics are generated from the tasks of the run workflows as well. Additionally, the links to the original workflow documents are stored in fields of the temporary documents in the second step. These will later be the occurrences of the topics. After that the topic associations have to be build in the third step. For this purpose the connections between the tasks of the workflow models are read and transitioned into topic associations of the topic maps.

The generation of the topic map from the temporary documents is then carried out by a software agent, a part of the above mentioned generic topic map engine.

Figure 5. Visualization of the user interface
This way, the user interface can be used e.g. to browse through versions of similar ad hoc workflows. Besides, the tool can be used to navigate through the steps of run workflows, e.g. to review the development of the content or to illustrate the path the workflow took through the process graph.

4 Conclusions

The described approach outlines a potential solution for a former unsolved problem of managing process knowledge of ad hoc workflows using new concepts of knowledge management. By the synergy of combining concepts of ad hoc workflow management and knowledge management, they leverage their mutual advantages and therefore, provide benefits for both concepts.

A prototype of the proposed concept is being implemented and parts can already be used for trial purposes. The finalization of the system integration is planned for the near future.

References