**Abstract**

Many of today's companies already have integrated workflow management systems (WFMS) within their IT-infrastructure which are mainly used for the core processes of the company. Furthermore these predefined processes are designed and implemented by specialists, whilst the process knowledge of the involved employees remains mostly unused. The daily business life, especially in office environments, often additionally requires flexible, rather short lived processes (ad hoc workflows), that can only be predetermined in advance to some degree. These two types of workflows have many interdependencies which are inadequately or not supported by currently available WFMS. For example some ad hoc processes that are used more than once and therefore get well tried by practical experience, could become established and important processes for the company. Thus these should be transitioned into predefined workflows in a traditional WFMS. The GroupProcess project examines the broad possibilities to support ad hoc processes in companies and creates connections to existing systems like WFMS, Knowledge- and Office-Management-Systems.

**1 Introduction/Overview**

Many of today's companies have integrated the Workflow Management Systems (WFMS) in their IT-Infrastructure which are used mainly for the core processes of the company. Furthermore the predefined processes are usually designed and implemented exclusively by specialists, whilst the process knowledge of the involved employees remains mostly unused. On the other hand, the daily business life, especially in office or administrative environments, often additionally requires flexible, short lived and sometimes urgent processes (ad hoc workflows), that can only be determined in advance to some degree and which are not or only inadequately supported by currently available WFMS. Until now, this type of processes has been viewed as not worthwhile to be automated. The GroupProcess project offers concepts and prototypes to meet this situation.

In section 2 we introduce the goals of the GroupProcess project on the application level. From the nature of ad hoc processes we are convinced that a very suitable or even predestined target platform for their support is a groupware-based environment. Therefore a definition and delimitation of the terms in the field of computer supported cooperative work (CSCW) and groupware are described in section 3. In section 4 and 5 we present the concepts and architecture of the GroupProcess project respectively. As a focus in this context our solution of supporting ad hoc processes in the proposed environment and the integration of ad hoc processes with a traditional workflow management system is described. Section 6 shortly discusses related research. Section 7 outlines concluding remarks, the current state of the project and the future opportunities.

**2 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. Because ad hoc processes are only partially predetermined, a system to support ad hoc workflows should be able to support continuous design of a workflow during its execution.

The knowledge about the whole process is often divided across several people. Thus 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.

One of the greatest challenges of the project is to design an intuitive user interface that enables even non-specialists to design and execute ad hoc workflows. As seen, an enhanced system for ad hoc workflows could be helpful to provide a system that is able to partially automate a 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 be stored firstly 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.

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 features of conventional WFMS because we are convinced that they are very suitable for their intended environment. 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. This is why workflow systems alone are not as successful as expected and 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. Communication systems like e-mail on the one hand and collaboration systems like WFMS on the other hand should grow together. Thus, there should be a linkage like the GroupProcess system to gain synergetic advantages of both system types.

Some ad hoc processes that are used more than once and therefore get well tried by practical experience could become established and important workflows for the company. Thus these should be transitioned into predefined workflows in a WFMS. By using the GroupProcess system, the stored 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.

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.

3 Delimitation of GroupProcess within the field of CSCW

To hierarchically decompose where the topic of GroupProcess is located within the field of CSCW, this section discusses the terms communication, collaboration and coordination. Later on, these terms will be used as modules for further concepts.

Three types of WFMS can be differentiated. Messaging-based Workflow Systems, Document-oriented WFMS and Production WFMS (compare with [5]). As we focus on office environments of companies and organizations, we concentrate on document-oriented WFMS. Peripherally, messaging-oriented WFMS are included in our approach as well. As a result of these considerations, we think that computer supported cooperative work (CSCW) or groupware technologies are the best basis for our concepts, theories and implementations. Fig. 1 shows the different concepts of CSCW communication, collaboration and coordination (compare with [2]). The delimitation of these terms is not homogeneous in the literature. An overview over the controversial discussed different views can be found in [2].
Communication in this context means the submission and exchange of information between people. In the context of groupware this specifically means store-and-forward or push-model. That is, information is transmitted ("pushed") from the sender to the recipient. However, communication-technologies are not appropriate for all kinds of teamwork. In some of these cases collaboration is the better way to work together. Collaboration relies on a shared space. Activities such as problem solving, brainstorming or discussing a topic are all forms of collaboration. Especially for many-to-many interaction, the communication concept reaches its barriers. In addition, messaging systems primarily concern with tracking files as messages in relation to senders and recipients. This makes it difficult for users to track information by topic. Thus, providing a virtual common workspace with a group-centered interface that allows participants to share information and ideas is the logical next extension. In contrast to messaging systems which use the push-model, shared database technology can be described as a pull-model. But also other technologies like video-conferencing are means of collaboration.

And there is yet a third category of activities that are supported by groupware: Coordination. Many business activities are of a more structured nature. Companies do not expect people to "collaborate" on processing an expense report; rather, the company defines specific policies about how an expense report has to be routed through the organization to be properly approved. Many people are involved, but the company's policies specify the coordination required between these people to meet a defined objective. The successful completion of a predefined business process depends upon the coordination of people in completing a set of structured tasks in a particular sequence. Coordination is using the concepts of communication and collaboration and adding control. To a great extent this is the domain of workflow automation systems.

The GroupProcess project resides mostly in the field of coordination, but in some cases, collaboration is used as a module in structured processes as described in the next section.

4 Conceptual approaches of the GroupProcess project

4.1 The GroupProcess Continuum

As outlined above we are convinced that workflow management must encompass and support a combination of both predefined process structures in the sense of process control (full automation), and open and flexible processes, whose structures will be determined or refined due to evolving circumstances during task processing (combination of automation and autonomous workgroup coordination and collaboration). The first type relates to today's existing corporate information systems infrastructures of highly structured large-volume transaction systems. The latter closely refers to the context of office systems based on more flexible paradigms like workgroup computing, CSCW, or groupware. Thus, we do not regard them as two distinct or even opposite concepts, the more or less rigid structures of workflow automation on the one hand, and
the flexible team-driven concepts of workgroup computing on the other hand. Rather, we synthesize both approaches using overlapping workflow (sub-)structures to form a basis for flexible and yet productive information systems design.

We started on the basis of the workflow-continuum by Nastansky and Hilpert presented in [1]. This has been further developed and extended to meet the requirements of the concepts we want to discuss more detailed in this paper. By presenting this scale we want to point out the categories that need to be differentiated from our point of view. We identify three different workflow categories whose details and substructures will be outlined below. The combination of these three categories provides a scaleable degree of automation for workflow management. We utilize well known concepts of information dissemination and messaging (as described in section 2), modifying and integrating them into a framework from which elements can be derived for maximum synergy depending on the actual requirements.

The basic patterns and some annotations describing the different types of workflows from a business process design point of view are summarized in fig. 2. The various annotations are intended to point out the continuous scale property of organizational workflows and the overlaps in underlying information and communication technologies.

**1a) Ad hoc Workflows**

As outlined above, ad hoc workflows (Fig. 2, col. 1) usually deal with unique and rather short-lived processes. These processes with very low frequency vary largely in their degree of complexity. In general, single tasks of this type of workflow can only be partially predetermined in advance, and are difficult to structure. Until now, processes of this type have been viewed as not worthwhile to be automated. In many cases these workflows are spontaneous and also urgent or confidential.

Both, initiation and execution of ad hoc workflows,
usually involve different actors. Ad hoc workflows may be recurrent in parts or they may reappear in a similar way again. Typical sample ad hoc workflows can be found for general purposes in office communication environments, in project management of individual tasks, or customer requests that cannot be matched with any known standard service pattern within the organization.

(1b) Open team task within an ad hoc workflow

Collaboration in its specific meaning in this context has been defined above. Using this definition, a team task can be described as a task that has to be accomplished in a collaborative way. So the main notion is that this task has to be executed and completed by a team. A workflow of the type “Open team task within ad hoc workflow” is a workflow containing at least one step that has to be accomplished as a team task. Before the team job is started or after finishing it, there may be other parts of a routing path (in this case ad hoc defined parts) that have to be accomplished. This may for example be an offer to a customer which has to be discussed with colleagues and afterwards has a structured but yet flexible way to be finished, e.g. putting it in a standard form, printing it and approving it from a person that resides in a higher hierarchical position and is able to make the decision. The embedding of this open team task concept in the GroupProcess approach is shown in fig. 2 in column 2.

(1c) Ad hoc workflow with a sub-process or cluster

This type of workflow may occur because of two reasons. The first is reducing the complexity of workflows by building clusters as a tool for hierarchical decomposition. This way complex tasks can be created as just one item and then later on be defined more precisely. The second reason is that an ad hoc workflow may contain at least one task that belongs to the responsibility of another person, team or department. In this case, the initiator may want to know how the other organizational entity achieves the objective of the task. Another reason for the subordinate organizational entity to design the process could be that it helps to structure it. Both described extensions of regular ad hoc workflows may occur in one workflow. More than one occurrence is possible as well.

(2) Semi-structured Workflows

Subsequently, we describe three major types of semi-structured workflows: the intersection of predetermined and open team oriented tasks, the employment of an ad hoc workflow as a part within a business process framework and the ad hoc modification of predetermined generally well-structured workflows. Any of these semi-structured workflow types may be combined with each other.

(2a) Open Team Task Within Standard Workflows

This type is similar to (1b). The difference is that a well structured workflow exists and the team task is one part of the predefined workflow in this case. The team task is used analogously as described in (1b). An example could be a team meeting on a regular schedule which needs some preparation before and some assessment or evaluation afterwards. The tasks beside the team task could be well structured and therefore be designed a priori for this type of workflow.

(2b) Ad hoc Sub-workflow within predefined Workflow

This semi-structured workflow is characterized by integrating such types of tasks into predefined workflows that are completely open but the initiator expects that a structure will be established for that task by its editor. In the context of GroupProcess, we call this sub-workflow a cluster. Again, it is rather similar to the same module in (1c). The main difference is that in this case we have an existing well structured workflow, in which one step is always different but it might help that this sub-process is being recorded, e.g. to use it again as an idea to solve a similar problem or for others to learn how problems have been solved or just for reporting reasons.

(2c) Ad hoc Modification and Exception Handling of Predetermined Workflows

This is another type of predefined workflow with modifications at run-time by ad hoc modifications and dynamic re-routing of the workflow for special cases and exceptions (Fig. 2, col. 2c). In comparison to (2b) we have a generally well structured predefined workflow, without uncertain steps. In some use cases, however, it may be necessary that an exception from the specified way of execution of the workflow becomes necessary. Ad hoc reactions may be required by specific circumstances that come up during everyday work. A workflow system that does not provide the flexibility for the user to respond to this highly probable type of real life necessity forces him or her to leave the context of work within the workflow system - thus possibly causing fatal disruption. A solution to the workflow breakdown could be tried by physically meeting or calling an appropriate person whose interaction is necessary to continue the job. Another way to handle the disruption could be to write a paper based memo or use e-mail describing the nature of the problem and asking
for solution. The disadvantages of a required synchronous communication described in the first alternative are obvious. With the second memo based approach this can be prevented. Still, the effort for explaining the information context of the disrupted job may be immense.

Exception handling and ad hoc modifications can be distinguished in this type of workflow. Ad hoc modifications can be regarded in two ways:

1) Questions to someone else: An ad hoc workflow is started from the current node and re-enters the predefined workflow model again at the same node after the exception flow has ended. Afterwards the predefined workflow continues normally.

2) Detour: Disregard the transition to the next node in the workflow model. Build an ad hoc workflow as an alternate route and re-enter the workflow model in the next step.

Both cases can be looked upon as ad hoc workflows that are started at the current position of a predefined workflow. In some cases it could be useful that the predefined workflow is changed in the way the workflow goes along with the ad hoc change. This could be indicated for instance if the change happens again and again or if the responsible organizational entity wants to change the process in that particular step (delegation). As with all other activities within a workflow system, the exception handling must be thoroughly recorded. The audit trails can be found as entries in the workflow protocol and can then be graphically displayed by the GroupProcess system.

(3) Predetermined Workflows

These are the well known standard workflows which are used in production WFMS as well as in administrative WFMS. Standard processes usually consist of highly recurrent structures (Fig. 2, col. 3). These workflows pass through the same predetermined order of steps over and over again. Very often they consist of routine activities.

A one-time investment in task analysis and the development of automated applications seems to be profitable for high volume processes. It should be considered as well for typical sequential processing patterns being followed at several occasions within an organization and thus being re-usable within many workflows. Pre-designed process models determine the complete procedures with their activities, agents, and routing paths including possible alternatives in advance. The involved editors of the tasks within the processes with their position inside the organizational structure and their roles have to be included.

We will now shortly discuss the question which of these workflow types will be supported by the GroupProcess concept directly, which are supported by existing workflow management systems and which are supported by means of a combination of both: The types (1a) to (1c) are directly supported by the GroupProcess system. The functions for the cooperative parts (group tasks) are provided by the underlying groupware platform. The sub-type (2b) is also already supported by the document-oriented WFMS which we chose to combine with the GroupProcess approach (“Workflow enabled Enterprise Office” a product of Pavone AG, Paderborn, Germany). The sub-types (2a) and (2c) will be supported by a combination of GroupProcess and this document-oriented WFMS. The workflow type (3) (predetermined workflows) is supported by current workflow management systems. Although predetermined workflows are not directly supported by the GroupProcess system, there is a linkage between predefined workflows and the processes supported by the GroupProcess system, as the development from predetermined workflows out of ad hoc workflows is one goal of the GroupProcess system.

4.2 A Paradigm shift: Comparison of ad hoc and traditional WFMS

In the previous sections it has been discussed that we consider a much more flexible workflow-management solution necessary. To reach this goal, some of the paradigms of current WFMS have to be rethought and perhaps have to be modified.

One paradigm of current WFMS is the separation of build time and run time of a workflow (compare with [8]). A workflow model is entirely designed during the build time and afterwards executed during the run time. This approach is not suitable for the management of ad hoc processes. Because of their nature, ad hoc processes cannot be completely predefined. Consequently they should be partially predefined and started afterwards. Thus our conclusion is that build time and run time have to be merged for the purpose of creating a system that is capable to manage ad hoc workflows. This ensures that the design of processes can be continued while the process is already running.

Another aspect of the current workflow paradigms is the separation between workflow model and workflow instance. This is a very suitable solution for highly recurrent predefined workflows. The situation for ad
Ad hoc workflows is different: Because they are not executed in the same way a second time and have a high dynamic of changes, they do not need to be stored as a model. Rather, the model and the instance form an integrated whole. If a similar ad hoc workflow ought to be used a second time, an ad hoc workflow that has been executed before can be chosen as a template for the new process. This template can then again be modified while the process is already running.

Furthermore it should be possible that ad hoc processes are being build by the participants of a workflow execution in the organization. We want to accomplish that goal by enabling the system that a process can be further developed by a different person while the process is running, e.g. by the editor of the current task or by the initiator of the workflow.

Participatory design of organizational structures for workflow management systems has already been suggested by Ott and Huth because it is looked upon as a more efficient way to design organizational structures. Based upon these thoughts, the participatory design of the process structure can be viewed as continuation of that approach which also offers some options for a higher efficiency, in this case for process modeling.

The organizational structure proposed in the GroupOrga project by Ott and Huth in [4] is also appropriate as an organizational structure to choose the organizational entities for the design of ad hoc workflows. The modeling of organizational structures offers the necessary flexibility to always have the correct organizational objects available.

Because of the dynamic and spontaneous nature of ad hoc processes they are often directly bound to people rather than more abstract organizational entities like departments or roles. Ad hoc workflows often take place in the core team of the initiator of the process. If a short-lived process is partially planned, most designers have other persons within their team in mind, that they want to choose directly to get the job done. In this case it is unlikely that an abstract organizational entity is chosen. This is more often the case, if the workflow crosses the frontier of the team or even organizational boundaries. Then the designer does not know in most cases which person of the other team or other organizational unit is able or willing to work on the task.

The most important aspect for an ad hoc workflow management system is that it is easy to use in most cases. But if structured workflows should be created by the use of previously stored ad hoc workflows later on, an abstraction from the particular persons to their organizational entity has to be realized. At this point a relation from the person to his or her roles and department needs to be used. This relation is of course not unique. Thus, there has to be some kind of selection of the current positions, roles and department of a particular person which might be suitable as the organizational entity to fulfill the task.

An example for the type (2b) "Ad hoc Sub-workflow within predefined Workflow" could be a workflow that is meant to reflect the process of fixing a software problem. The structured steps might include the initial registration of the software problem, submission to a project manager, assignment to a programmer or specialist, routing to quality assurance, delivery to a configuration management specialist, and after figuring
out a workaround, posting it to a public reference library (e.g. the World Wide Web or bulletin board) ready to be downloaded by the customers. Throughout this process, however, there are likely to be at least one unstructured step that cannot be anticipated or automated, that is the solving of the problem itself. Coordination, then, is more than the automation of a sequence of structured tasks, bringing people into and out of a process as required. Rather, when we look at how work is really done, we see that knowledge that is essential to the completion of a process is acquired as a result of the relationships among the various participants, outside of the context of the process itself. Complete coordination includes support for informal conversations like e-mail, discussion databases and reference publishing systems, that allow people to gather the information they need to get their jobs done, especially when these conversations happen in the context of a more structured process. Our

5 Architectural considerations

The architecture of the GroupProcess system, which is displayed in fig. 3, has been derived from the workflow-continuum and the given environment. Process-, organization- and application-database, organization-modeler and -interface and workflow-modeler and -engine are components of the traditional WFMS (denoted by the dotted line in fig. 3). The core modules of the GroupProcess system are the ad hoc workflow engine, the ad hoc workflow-modeler and -viewer and the organization-modeler, -interface and organization- and application-database (displayed in dark gray in fig. 3). The model of ad hoc workflow is directly stored in the document of the corresponding workflow case. Thus there is no connection to the process database which stores the predefined workflow models. The tool for the transformation of ad hoc processes into structured workflows and the module for e-mail tracking and routing are optional. For the integrated WFMS for ad hoc and predefined workflows all modules are used.

The primary target environment of the GroupProcess project is an integrated groupware-based office architecture. Nevertheless, to consider the various occasions that involve routing via e-mail, the prototype pursues the concept of encapsulated message objects that can be sent to and exchanged with external systems as well. As a conclusion, all routing information of an ad hoc workflow in the GroupProcess system is stored in the document itself, regardless which of these two different types of routing occurs (compare with fig. 4). Besides, this also ensures that each document can have its own workflow instance and that the model can retrieved from the document for further use as discussed above.

The routing information consists of two major blocks. The ”Workflow protocol” contains detailed information about task definitions that already have been worked off, including information such as the editor, the list of tasks, information about joined documents and the routing path. The protocol is write protected and cannot be changed anymore. The
"Workflow definition" contains all routing and task information that have already been specified for the further flow of the document. In many cases, these information can be changed at any time by the current editor of the document. The workflow protocol and workflow definition can be displayed as an integrated workflow model. A workflow-document can also contain the workflow modeler itself, which is necessary to enable the user to enter routing information even if the initiation of the workflow takes place in the mail database of the user instead of the integrated office environment. Therefore the whole modeling system has been created using platform independent internet technologies. This also enables a user to design and use workflows through the web with a browser interface. Moreover the storage of workflow model, content and modeling tool allows workflows to cross organizational boundaries.

As the degree of abstraction in ad hoc processes is low, in most cases the editor of a task is a person, that can be chosen from the users favorites list, the address book of the organization or, if the process occurs in an integrated office environment, from the organization database. In that case, the modeler offers advanced options for choosing an editor. These can be all types of editors the organization database offers, e. g. departments, workgroups or roles.

The initiator of a workflow is the person that first defines tasks and forthcoming editors of these tasks to be fulfilled in the context of the given document. If tasks in a workflow can be finished by different editors at the same time, a copy of the document has to be created for each parallel editor. These documents are called split documents. The initiator has to decide if the workflow can result in several documents or has to end up in a single document. In that case, the workflow definition is called a "cluster". By definition, a cluster has only one defined ending task. Thus all split documents that have been created within the cluster have to be joined before an editor can finally finish a task. In general, the editor of a task can decide about the further routing path of the document. If the workflow definition already contains tasks other than the current one, the editor can change the definition or accept it as is. Only in a cluster, the design capabilities of the editors are restricted. The definition of the workflow can be locked by the initiator, so the editor of a task cannot change the further document flow. In a locked workflow model, the initiator can design the flow as if the routing would occur in a WFMS for predefined workflows, so definitions such as alternative routing paths are allowed. If the design is not locked but the workflow has been defined as a cluster by the initiator, the restriction is that the design has to lead to one document.

In case the current editor of a task needs to further differentiate that task into a sub process to get the required result that is needed to work off the task, the current editor can initiate a sub process. If the current task is located in a cluster, the sub process has to be a cluster as well because the product of the process has to be a single document. Otherwise the editor, who is the initiator of the sub process, can decide whether the sub process should be a cluster or a process that can have more than one resulting document.

Special care has to be taken in designing the user interface. It has to be easy to use especially for the most often demanded features. Otherwise the system will fall into disuse and fail. Fig. 5 shows a Screenshot of a prototype of the modeling tool and an idea to integrate an organizational interface. 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 be automatically generated as a user interface that contains the favorites list of people of core team members to choose from.

6 Related work

The approach of the GroupProcess project differs from other approaches in the literature. Other current ad hoc WFMS (e.g. [9], [10] or [11]) are often enhancements of WFMS supplying mechanisms to
handle “unexpected exceptions” (compare [11]). Other than these, the starting point for the GroupProcess project is an ad hoc workflow management system which is then in a second step integrated with a traditional workflow management system. Another difference from other approaches is the extensive participatory aspect. Participation has already been mentioned in the literature but not to extend of complete participatory design (compare e.g. [12]). Moreover the integration into a groupware platform also differentiates GroupProcess from others approaches which are primarily integrated in transactional information systems for production WFMS.

7 Conclusions

A vision of an ad hoc management system that integrates workflow-, knowledge- and office-management-systems from a process driven perspective has been presented. From our point of view, this system is the missing linkage between the above mentioned systems and thus is beneficial for all these types of systems. Therefore it helps to leverage their inherent advantages. Not only because of this, there are already some companies that have shown interest in such a solution.

Prototypes of the core module are being implemented and parts can already be used for trial purposes. The tool for the transformation of ad hoc processes into structured workflows and the module for e-mail tracking and routing are not yet finalized.

References


