Workflow Management Systems: Ensuring Organizational Flexibility by Possibilities of Adaptation and Negotiation

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Abstract: Characteristics of workflow management systems must be adaptable by the users themselves according to the dynamism of organizational structures and of the conditions of cooperative task performance. In the case of those systems, adaptations which are initiated by individuals also affect other users in most cases. Therefore, a process of negotiation is required. A design principle called negotiability should be introduced. It helps users affected by adaptations to comment on them or to reject, accept or modify them. Supposing that the configuration of workflow management systems leads to a fixing of organizational structures by technical means, adaptation based on negotiability can be used to make those structures more flexible.

Keywords: workflow management system, flexibility, adaptation

Introduction: Relevant characteristics of groupware and workflow management systems.

In the case of single user systems it is widely accepted in H-C-I research that these systems should be adaptable by the users themselves. In the following section it is argued that users can also have the possibility to adapt groupware to changing conditions of task performance and to the dynamism of organizational structures, if the negotiation necessary for managing the adaptation is supported by the system itself. In this paper, reasons are given for the approach that the ergonomic design principle of adaptation should be completed by a concept we call negotiability. By using this concept it is also possible to modify those features of a system which affect more than one user and, furthermore, are of organizational relevance. In our opinion the changeability of organizational structures on the one hand, and the flexibility of groupware — especially of workflow management systems (WMS) — on the other hand, are dependent on each other.

The arguments and results presented in this paper are based on the following methodological considerations. WMS are at the start of immense dissemination and at the moment, the phenomenon is not uniquely defined or specified. From a methodological point of view, this situation implies disadvantages as well as advantages. On the one hand there is only little empirical experience with the use of WMS. With respect to the problems which are already observable it is hard to decide whether they are caused by teething troubles or by fundamental obstacles. On the other hand the way in which WMS are developed has still not been definitely established and therefore can be influenced by socially oriented design principles. However, there is no detailed empirical evidence for the adequacy of such principles. Therefore, on the one hand, we argue with the help of empirical considerations which we gained by inspecting a number of cases. On the other hand, we are theoretically trying to transfer results and discussions from human factors research to the field of WMS.

Our approach is based on the following understanding of groupware and WMS: Groupware is a type of software which allows working people to reciprocally support their communication, cooperation and coordination. The more all three aspects are jointly supported, the more it is appropriate to use the term groupware. It must also support cooperation if the users' work is directed by others or is embedded in hierarchical structures, or if conflicts of interests occur. In this sense groupware is not a kind of system which can only be used in the case of specific organizational structures like teamwork. Groupware can especially help to overcome barriers of time and space. Due
to these physical possibilities, groupware can also help to overcome hierarchical barriers and distances between departments.

WMS are systems to support the handling of procedures in which more than one employee is involved. On the one hand the administration of documents is supported and regulated as well as access, distribution and archiving. On the other hand business processes are represented by WMS to regulate the coordination of cooperation. This concerns scheduling, responsibilities, rights of access, conditions for activities, the sequence of discreet tasks etc. The sequences need not be linear because parallel processing can be controlled and synchronized by WMS, too. By introducing WMS, organizational structures and regulations can be fixed partially by technical means when the software of a WMS is configured. Thereby compliance with these organizational regulations is automatically supported and guaranteed. Furthermore, such systems offer the possibility to simulate task processing and they provide data to control the progress of work and to survey the performance of employees. We can differentiate between two opposite types of WMS by considering the question of whether the task performing of potential users is coordinated by them or by others, i.e. the management. If the management exclusively determines how a procedure is processed, they have the flexibility to change procedures by using technical means how and whenever they want. From the users' point of view the coordination is controlled by the system. In the opposite constellation the person currently working on a single case is authorized to specify the next steps and tasks to be done. Furthermore, he or she can change existing determinations — if somebody else has already determined the workflows of the processing of a task. Thus the coordination is controlled by the user.

The more the participants have the possibility of self-coordination, the more it is appropriate to consider WMS as groupware, e.g. comparable to the COORDINATOR [17]. The category of WMS where the coordination is completely determined by the management is justifiably [5] not considered as groupware. Similar problems with distinguishing the term WMS arise with systems which are exclusively able to model procedures but not to run them, or which are mainly used to administrate a large number of documents (document image processing) but hardly contribute to the controlling of procedures.

Groupware and WMS as described above have the following features in common: They offer functions which do not only affect the user activating them but also other participants. In the following, these functions are called global. There might also be functions which are — more or less directly — activated by more than one participant. One person might prepare the activation of a function while the other one fulfills the conditions so that the activation can really happen.

**Configuration, adaptation, controllability**

Before the effects of WMS — especially on organizational structures — can be analyzed, it is useful to explain what is meant when we speak about the features of a specific WMS. Three levels can be considered to differentiate between the features as they:

- characterize the system as it is delivered by its producers. In this state the WMS is still not able to support any office procedure. However, it can be considered as a shell which can be used to configure the system.
- are established after the system has been introduced by a company and its controlling tasks are defined by the management and implemented by using the possibilities for configuration.
- can be observed when the system is used at a specific moment. Then the state of the system is also characterized by the adaptations and choices being made by the users.

The effects of a WMS depend on the features as they are determined by the second and third level. Yet the characteristics which are implemented by the producer (1. level) determine the degrees of freedom the company has when it intends to restructure its organization with the help of a WMS. The reciprocal influence between organization and WMS can be explained by referring to the

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1. This definition is based on a report by HALEs and LAVERY [5]. In their terminology (office) procedures are a sequence of tasks and a case is represented by the facts and the objective which require the invocation and processing of a specific type of procedure.

2. In the following the term participants means anyone authorized to use a system. Anyone actually using a system at a specific moment is called user. Users who invoke a function are called activators, those participants whose using the system might be influenced by the function are called affected. Functions are single software procedures; the term is used to avoid confusing the difference between office procedures and software procedures.

3. Functions are global if they establish without exception, connections to other participants and influence their possibilities for action. A function (e.g. changing the fonts of a text) is called local if it first of all has only an effect on the working area of its activator. Only if its result is used by a global function (e.g. submitting the text) does it affect other participants.

4. For example: Person A determines that a document is automatically forwarded to person C, if someone modifies the content of a specific data field. That means that A is preparing the forwarding function. If B changes the data then he is in the end the person who triggers the forwarding of the document to C.
process of introducing such a system. To avoid the explanation becoming too complex, we concentrate on processes which occur inside a company and therefore we do not refer to telecommunication and telecooperation.

We assume that a company frequently has good reasons to improve its organizational structure or to adapt it to changing conditions. Usually the decision to introduce a WMS is related to the changing of organizational structures. Such a change mainly aims to obtain an optimization to overcome the barriers between departments, to minimize the length of a procedure, to permanently establish quality assurance, to achieve more customer friendliness, to avoid transfer between different media etc. Nowadays most of these aims are summarized by keywords like lean production, lean management, business reengineering etc. and are characterized by a changing perspective from product orientation to process orientation.

Figure 1 presents three different stages: configuration, adaptation and control. This differentiation is explained in this paragraph. We chose the intention to improve organizational structures as a starting point and we suppose that the business process is reorganized and a WMS is introduced. Configuration of WMS is the projection of the business process model onto the WMS. That implies that the programming of the WMS is completed and/or parameters have to be specified according to the companies’ conditions and requirements (e.g. determination of roles, procedures, rights etc.) which are actual at the moment of installation. Configuration can be done with the help of external staff (like software developers, consultants etc.) as well as by internal personnel (DP-department, system administration, etc.). Configuration contributes to the technical fixing of organizational structures with the help of software. The fixing requires these structures to be formalized and described very clearly and explicitly. Roles, rights, duties, tasks, scheduling etc. must all be determined in detail. It is decisive how the configuration determines the relation between user controlled vs. system controlled cooperation because this characterizes the whole process of working together. Furthermore the introduction of WMS and the intention to change organizational structures also influence the non-technical processes of communication and cooperation (see dotted circle, fig. 1).

The circles in fig. 1 demonstrate the dynamism of change: The result of configuration will be revised according to the objectives of an enterprise and it might become obvious that a reconfiguration is necessary. In contrast to adaptation, reconfiguration requires the company to decide to modify regulations and standards underlying their business processes. Reconfiguration is initiated by the management and carried out by system administrators or by the customer service.

By adaptation we understand that a modification of WMS based business processes or of its objects is initiated and carried out by the users themselves and affects not only one case but a number of similar cases. Adaptation is based on the users assessing the system and the consequences of the configuration. Therefore they should refer to the procedures they have to contribute to and to the types of tasks they have to perform. In the course of usage and assessment it might become obvious that a specific procedure or type of task requires an adaptation of the system to improve handling. For ergonomic reasons and with respect to efficiency users should mostly be able to establish this adaptation by themselves. It is too lengthy and awkward if the adaptation is managed in the course of reconfiguration by involving a central system administration or even an external consultant. Most users would rather work with the unadapted system than initiate an adaptation by
reconfiguration. Therefore in every situation of usage a user should be able to adapt the system. The adaptation must be related to the tasks and procedures this user has to contribute to and must only affect participants the user is cooperating with. In spite of this argumentation, most companies do not allow or support such an adaptation because they fear that inconsistency may arise. Therefore in the next sections we demonstrate the necessity of this user oriented flexibility and we propose a concept to avoid inconsistency and conflicts.

The inner circle of figure 1 illustrates that a user discerns that the system's configuration and default values do not optimally suit a specific task or case. By the term control we mean that the user should have the possibility to change parameters and to choose alternative options so that a task can be efficiently performed. This is typically necessary if an exceptional case occurs. This case may require a workflow to be reversed or additional information to be asked for or a step of the task processing is delegated. Similar possibilities are also required within ISO 9241/10 [7] by the dialogue principles suitability for the task and controllability.

Figure 1 expresses the dynamism between changes and assessment. We assume that this dynamism has a characteristic effect on the reciprocal interaction between technical and organizational innovation. We suppose that organizational structures are not the product of a terminating design process, but a changeable interim result from a continuing process. Furthermore, we developed the differentiation of fig. 1 because, especially in the case of adaptation a system-based support to avoid conflicts might be worthwhile.

Flexibility: Requirements and problems

In scientific contexts the statement that not every aspect of an organization can be anticipated or formally regulated, might be considered as trivial. E.g. MARCH (1991, [11]) outlines that decision making is not exclusively based on rational principles or SUCHMAN (1987, [16]) makes clear the limit of human capacities or willingness for planning. Regulated and unregulated structures supplement each other, otherwise organizations would not be sufficiently able to act flexibly. This understanding should be taken into account whenever the introduction of software requires a formal and explicit description of organizational structures. The benefits of organizational flexibility for an enterprise are based on the following aspects:

- External requirements might change (pressure from competitors, changing demands of customers, ...)
- Internal requirements are changing frequently (fluctuating personnel, scheduling problems, lack of resources, working atmosphere may change, ...)
- The optimal coordination of shared working processes cannot be totally anticipated (concerning informal communication or making use of opportunities).
- Adaptation to the increasing experience of staff should be possible.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Considered Cases</th>
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<td>(Abbreviations in parentheses are used to make references in the following paragraphs)</td>
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<tr>
<td>- Processing of application by the planning department of a civil administration. (plan dep)</td>
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<tr>
<td>- Acceptance and processing of advertisements which are printed in phone books. (phone ads)</td>
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<tr>
<td>- Processing of new contracts which are submitted to an accident insurance company. (acc ins)</td>
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<tr>
<td>- Processing applications for social benefit in a civil administration. (soc ben)</td>
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- Registration and distribution of mail in a federal ministry. (min mail)
- Usage of a WMS (Domino) in a purchasing department (KREIFELTS a.o. [9]). (Domino)
- A company which rents housing uses a system which automatically distributes jobs to self-employed manual workers if something has to be repaired in a house. The documents representing the jobs are submitted and processed with the German videotext system. (job distr)

Because of this, handling of exceptions and improvisation characterizes much group activity. GRUDIN (1994, [4]) gives a lot of examples for these characteristics and refers to several studies. But, to derive design principles in the case of WMS it is necessary to consider problems which

5 For example: An employee in the customer service realizes that there is a deadline after which the conditions he offers in his contracts are no longer valid. Therefore he would like to make sure and to check that the completion of the contracts which are processed by an WMS will happen in time. Thus he adapts the system with the effect that he is automatically informed every day about the progress of the processing of every contract. This adaptation should only be active until the end of the deadline, afterwards the information is unnecessary and offers an unjustified opportunity for surveillance of other participants.

6 Example: Suppose the employee in the customer service has only one contract which is very urgently due by a specific deadline. Thus he should be able to connect a note to the document representing the contract. This note can ask every participant working on this contract to inform the employee about progress or difficulties in this single case.

7 This case was reported by MAMBREY and ROBINSON [10] and intensively discussed on a CSCW '94 workshop on critical considerations in the creation and control of personal/collective communication spaces.
typically occur when WMS are used or when – in a previous stage – business processes are made explicit and modeled to prepare the introduction of a WMS. Therefore we investigated a number of cases ourselves (see table 1, first four cases) or the reports on case studies. The case studies are in the end characterized by one of the following constellations:

- A kind of WMS is already used (Domino, job distr) and we investigated the experiences with these systems as far as reported by others.
- We tried to give a formalized and explicit description of business processes and organizational structures (acc ins, phone ad, soc ben) intending to project them onto a WMS.
- Administrations were investigated which have already tried to extensively formalize their procedures (plan dep, min mail).

The first case study was conducted in 1992. It was prepared by interviews with the heads of department of the civil administration and by investigating the technical systems and the documents describing the business processing. We interviewed 19 employees in different hierarchical positions by using an interview guideline which concerns the following topics: biographical data, characteristics of the workplace, organization of work, problems with cooperation, proposals for improvement. The main part of the interviews dealt with cooperation problems. After open questions for each kind of problem we systematically asked about problems with communication, inflexibility, coordination, transparency, access on information etc. The protocols of the interviews were independently categorized by two or three scientists.

Three further case studies (phone ads, acc ins and soc ben) were conducted in 1994 by a group of students who were preparing their project. The preparation of these case studies was similar to the first case. An interview guideline was used which was orientated towards the comprehension of the business processes and towards possibilities to make the processes more efficient as well as to increase the accordance with human needs. The guideline contains 16 main categories like processes, tasks, position, information and communication, cooperation, qualification, quality, motivation, freedom for decisions, work load, possibilities for job enlargement etc. In every case about five people were interviewed who had to carry out tasks which were typical for the processes under investigation. The results of the interviews were used to configure WMSs and to improve the business processes. During the configuration a lot of problems became obvious when one tried to formalize the processes and the relations of cooperative work. Furthermore, the interviews had sometimes to be supplemented with additional questions. The improved processes could not be brought into reality, they were only simulated.

The other case studies were not carried out under our responsibility. Thus we had to rely on reports but we refer to these studies because they outline some interesting additional problems. In the following we describe problems which could be avoided if there were more chances for flexibility and adaptation:

**Insufficient flexibility concerning the integration of formal and informal structures**

- There are definite regulations about whom questions must be posed to if data is incomplete. By contrast this regulation is frequently ignored so that the processing of a procedure can be accelerated by asking people who are directly available. Neglecting those unofficial channels would result in a waste of time (acc ins). In another case (soc ben) in every situation of task processing informal information sources were potentially relevant. This multiplicity of informal sources could not be represented by the WMS.
- Persons who are not officially involved in the-processing of a procedure are sometimes requested to look at documents and to leave an informal comment on them. In spite of this modus operandi WMS might restrict this possibility to persons who are officially part of a procedure (Domino, [9]).
- In one company (phone ads) customers' questions should only be answered by assigned authorities. Nevertheless it would be a disadvantage for customer friendliness if employees were technically obliged to accept this regulation in every case.
- Office workers are used to having the possibility of making handwritten notes on contracts (paper version) to highlight specific passages etc. If the contracts are transferred to electronic forms, these possibilities are seriously reduced (depending on the type of the system) (phone ads).
- Electronic documents must partially have a paper based version for legal reasons. This paper version has to accompany the document from workflow to workflow. Flexibility is seriously restricted because every modification has to be duplicated. The electronic documents cannot be split to enable parallel processing (phone ads).

**Inflexible sharing of work or sequences of task processing**

- If jobs are distributed automatically by a system, the affected workers have no chance to choose their tasks according to their interests and their capabilities. Furthermore, they cannot forward the jobs to other workers and they cannot split the jobs to delegate specific tasks to other persons (job distr).
- In exceptional cases employees let the case pass through though the person who is authorized to sign cannot be
reached. These persons feel experienced enough to act in this way at their own risk. Sometimes they subsequently asked for the authorization of a case they had let pass through or they asked the superior’s superior for a signature. If this possibility were neglected by fixing the rules with a WMS the quality of the service would decrease (plan dep).

- The sequence of task processing is not always clearly determined. Therefore representing the process on a WMS would require artificial sequencing (soc ben).
- In some situations an employee must transfer all his documents and rights to another person who is standing in for him ad hoc. Therefore he himself should be able to make all necessary adaptations (e.g. modification of access rights). If this had to be done by a centralized administration serious delays would have to be risked (acc ins).
- A number of documents (each of them representing one case) can be collected in a folder and be assigned to a higher level document (e.g. a list of prices). If this constellation is carelessly projected onto a WMS, the cases can only be forwarded all together which causes unnecessary delays (phone ads).
- We found complaints that the sequences are too awkward or that too many people are participating in the processing of cases. Sometimes people are forced by regulations to submit information which later on must be corrected (plan dep).

Problems with the integration of new cases or non-official elements

- Some procedures do not officially exist but are processed as well as the formally regulated procedures. Similarly unofficially existing documents can be found in administrations. Sometimes it can become necessary to integrate a “non-existing” case into an official procedure (e.g. if a piece of non-official mail seems to be so important that it has to be officially registered and archived). In the case of WMS based procedure processing, this integration can be considerably difficult (min mail).
- Exceptional cases cause the relevance of documents and tasks which are not planned to be part of the official procedure. Some regulations are too rigid causing the integration of new elements (tasks and documents) to be impossible. Therefore the possibilities of handling exceptions are not regarded as sufficient (Domino). Occasionally the processing of an exception requires some questions which have to be answered by other participants. Thereby it might be difficult to create a document which contains the question and can be easily integrated into the actual procedure (phone ads). These difficulties arises if no-one can anticipate the situations in which these questions might become relevant.

- In the case of social benefit, starting a process is constrained by the condition that no other way for social support or for earning money is possible. Thus the set of possible cases is defined by a negative list of conditions. Therefore the variety of possible cases cannot be formally described.

Problems with canceling

- Users are occasionally obliged to change data put in by other participants some steps before the actual task. In these cases, the users do not like starting the whole procedure a second time. But the possibility to modify single data is frequently not offered because it is feared that inconsistencies may occur (Domino).
- Canceling a case does not always mean that all its traces are completely erased. Mostly, cases are only partially canceled and it is difficult to anticipate how this partial canceling has to be reasonably processed. A formal regulation of canceling procedures makes it difficult to be efficient and on schedule (acc ins, phone adds).

Inflexibility of transparency

- In most cases we investigated, users are interested in knowing how far a case has already been processed or who has put in what data and who has made which decisions. On the other hand — e.g. depending on the working atmosphere — the interest might arise that data on performance or the existence of non-official procedures are not obvious to every one. If systems or regulations indefinitely determine the extent of transparency, the dynamism of conflicting interests as they might occur in companies, is denied.

The problems described above were observed by exploratory investigations. This means that they may occur but that we have no statistical evidence regarding the conditions and the probability upon which the occurrence of these problems depends. If WMS are used, the problems can be caused by the teething troubles of these systems. On the other hand there are fundamental problems. Some developers of such systems are systematically oriented to management strategies which are interested in unifying and formalizing procedures. Therefore these systems are not suitable for a management which is oriented towards flexibility. To offer solutions we have developed some propositions for the adaptability of WMS which might also meet the interests of employees.
Adaptability

In human factors research a multiplicity of possible kinds of adaptability is discussed which are usually related to interactive systems being used by single users. An overview is given by OPPERMANN [13]. The ISO 9241 [7] refers to adaptability by a design principle which is named suitability for individualization. By these principles the ISO 9241 also makes a distinction between controllability and individualization. The last one refers to adaptations which are unchanged for all tasks and sessions until the modification is explicitly withdrawn. The name individualization indicates clearly that this dialogue principle is only relevant for local functions which exclusively affect the working area of an individual. In the case of groupware and global functions we must take fundamental problems into consideration: First of all adaptation does not only affect a single user but usually all participants who might be affected by the function being adapted. Furthermore the adaptation of groupware and especially of WMS might change organizational structures.

Before we introduce the concept of negotiability which helps to minimize the first problem, we will discuss which aspects adaptability can refer to in the case of WMS. We differentiate between adaptation of information structures (a) and adaptation which influences the way users cooperate (b).

a) Users should be able to adapt a procedure and the documents which are processed. This might happen by

- extending the amount of information and integrating additional data (e.g. it must be possible to add a field for informal notes to every field of a document),
- defining references to other documents (for example to paper based contracts or pictures and drawings),
- changing the structure of the representation of information (the length and the position of a field on a form should be changeable),
- reducing the amount of information (e.g. to make documents anonymous if they are submitted to a specific group of participants or in exceptional cases),
- minimizing or extending transparency depending on the types of cases or on the type of cooperating participants (e.g. it makes a difference whether participants are from different hierarchical levels or not, or whether they are from the same department or not).

b) The way users cooperate and influence each other should be adaptable:

- Users should be able to specify how they can reach others and how others can reach them (e.g. a user should be able to determine that — in the case of a specific procedure — he can always be directly asked to comment on the relevant documents while in all other cases such questions should be preselected by another participant).
- The distribution of documents and - especially - the sequence of task processing should be modifiable (e.g. the splitting and parallel forwarding of a specific type of document representing a job should be possible).
- The use and distribution of access rights should be flexible (e.g. a user must have the possibility to determine that he can have access to documents which have been forwarded by him; on the other hand, a user should be able to refuse other users access to documents, which he actually intends to change.).

The kind of possibilities for adaptation described above are clearly different to approaches which are offered by some systems to increase flexibility. This can be explained by the example of handling exceptional cases. Usually an exception is considered as a singular case, which can be processed if additional possibilities for conversation are offered. The concept of AGOSTINI a.o. ([11], '157) is an example for such an approach. They propose that users should be able to submit some questions or requests to other participants until the exceptional case has been cleared.

By contrast, our approach allows the user to classify exceptional cases. If a specific type of exception occurs frequently the user should be able to adapt the system with the effect that cases of this type can be integrated into existing workflow procedures without any problem.

The next question is how these adaptations can be made by the user. Usually interactive systems can offer a lot of means and modes which serve for adaptation. Table 2) gives a list of examples (see OBERQUELLE [12]).

In spite of this technical support, users must be motivated and qualified to adapt the system by themselves. What makes it much more difficult is the fact that adaptation of groupware mostly affects other participants and the organization of task performance and work sharing. Therefore the adaptation by single users can be confronted with resistance: The management might prefer to restrict adaptation because they are interested in standardization and formalization. Also, other participants might feel that their interests are negatively affected if their colleagues determine the conditions of their work. The problems of conflicts in cooperative work are widely discussed by EASTERBROOK a.o. [2]. In the case of WMS, conflicts of interests may depend on:

- the role of the users. It makes a difference whether they are submitting or receiving a document, delegating or performing a task, surveying or triggering the progress of a case, requiring access or denying access etc.
• the position in a hierarchical structure (e.g. if the sequence of a procedure is changed so that the responsibility of a manager is ignored),
• work-load (e.g. it may happen that a user introduces a new form field which requires additional effort if data has to be filled in by another worker),
• the social situation (e.g. some participants might prefer their colleagues not to be able to observe how much time they need when they carry out their tasks).

These examples bring plausibility that one user's advantage of an adaptation might turn out to be a disadvantage for another user. To solve such conflicts, the possibility must be offered that the affected users can use a veto against the adaptation or can propose a modification of the adaptation. This requirement can be met by a design principle we call negotiability.

Table 2) Technical means for adaptation on different levels of complexity
1) Choice between two options: A function is activated or not; a parameter is specified by YES or NO (e.g.: access is allowed or denied).
2) Lists of parameters can be specified in different ways. The set of possible values need not be limited (thereby a list of all participants who are supposed to receive copies of a document can be specified).
3) The activation of a number of functions can be prepared so that they are automatically invoked when other participants use the system in a pre-specified way.
4) (Re-)structuring of forms or highlighting of particular data fields.
5) Building and insertion of new objects like textual or graphic elements.
6) Modification of pieces of programs (e.g. if the sequences of procedures are determined by a script language or by graphics they might easily be changed).
7) Building of macros by recording
8) Programming

Negotiability

With negotiability, groupware users who are affected by an adaptation should have the possibility to reject, accept or modify this adaptation or to comment on it. Subsequently, the activator of the adaptation may react in a similar way also using the same means offered by negotiability. The central idea is that this negotiation is offered by the same medium to which the negotiation is referring — in our case by a WMS. This means that the negotiation is supported by the system and that the sequence of discreet steps of negotiation are structured by software. Therefore we would like to emphasize very clearly that the term “negotiation” is only used in a figurative sense. We do not assume in any way that WMS offers the same spectrum of possibilities of negotiation as is possible by direct communication. It would be more appropriate to use a term like formal pre-negotiation, but this is too awkward. The consequence of this consideration is that negotiability must always offer a way out to more direct communication.

In the following paragraphs we try to give a detailed description of negotiability. An overview is provided by WULF [18]. We have no information about a prototype of negotiability in the case of WMS; KIRSCHNE a.o. [8] made one of the first attempts with database systems.

As a precondition of negotiability the configuration must determine which parts of a WMS can be subject of adaptation and negotiation, or not. Furthermore, the system must comprise a mechanism which can be specified by the configuration so that it can identify all situations in which negotiability has to be offered. In the case of adaptations on the complexity level 1) to 3) (see table 2) the negotiation can be triggered by analyzing the chosen options or the specification of parameters. E.g. if the system's address of a participant is added to a parameter list or, if a particular limit of a value is exceeded, it can be concluded that negotiation is necessary. On the higher levels of complexity of adaptation, negotiation can only be triggered by testing whether an object or a function is adapted which can also be used or adapted by other participants.

If the necessity of negotiation is identified, the next question is, when does the negotiation take place or is offered to the affected participant? Three possibilities can be taken into account:
• negotiation is offered at the same moment as an adaptation of a function has been started.
• it is offered when the adapted function is activated for the first time.
• it can still be processed after the use of an adapted function when its effects become obvious. In this case, our concept of negotiation would only allow the withdrawal of the adaptation to be negotiated, while the undoing of the effects requires additional effort and conversation.

8 One could be led to compare the structure for negotiability with the approach of the Coordinator [17]. We do not suppose that the formal steps for negotiation according to fig. 2 are comparable with speech acts (e.g. because natural speech acts can be indirect). Speech act based negotiation may occur, after the break off (see fig. 1) is used.

9 In the following text we write only about functions being subject of adaptation and negotiation. But our explanations can also be applied to objects and representations of information which are part of a WMS.
In the case of WMS a lot of asynchronous processing occurs. Therefore all three possibilities are reasonable because the participants of a particular negotiation cannot always be reached when an adaptation occurs. The explanation of negotiability mainly refers to the different options which might be chosen during the process of negotiation. Our description follows the structure of figure 2). The starting point of the process is established by the fact that a user (called A) tries to make an adaptation.

The affected participant (named B) is informed about A’s intention (double-lined arrow). Thus B automatically learns who intends to modify which function or object in which way. Optionally A describes his reasons. During the whole process of negotiation, the involved participants can exchange comments on the decisions they have made. This possibility is not represented explicitly by figure 2). Our concept offers five options to B:

**B1** First of all B can break off the process of formal negotiation e.g. if he or she prefers another way of communication. In this case the negotiation happens outside the system. The question is how A’s need for adaptation is handled until a compromise is found. Mostly it is appropriate that the adaptation is suppressed but in some cases it might be reasonable to choose another option (e.g. the adaptation is allowed but is limited to one week). Therefore it must be determined by the process of configuration which option has to be activated if the system-based negotiation does not result in a compromise. We call this **configured option**.

**B2** B accepts A’s adaptation. In this case the negotiation between A and B is terminated and A is informed about B’s acceptance. The result of the negotiation can be called the **negotiated option**. Consequently, the intended adaptation is brought into reality, or a further negotiation with other users is started if more than one participant is affected.

**B3** B might feel unsure about how to make the right decision. Therefore he can give his or her acceptance until withdrawn. We know from daily life that we frequently do not know the context or the effects of a decision we have to make. Thus it is reasonable to offer a chance to withdraw the decision. In this case the activator of a potential adaptation (A) must have a chance for further reaction (accepting, rejecting or modifying the possibility for withdrawal).

**B4** B proposes to change the intended adaptation. This we call **modification**. B makes his or her proposal by trying to modify the function which is the subject of the negotiation by doing it in his or her preferred way. Also in this case, A must have a chance to continue the negotiation.

**B5** B also has the possibility to reject the adaptation. This **rejection** requires a decision between two options which has to be made during the process of configuration. One option is that the negotiation is terminated at once and the **configured option** takes place. The other option is that the negotiation can be continued by a reaction from A.

In the case of potential withdrawal (B3), modification (B4) and rejection (B5, depending on configuration) further reaction is required from the activator A, which can be described by the following differentiation:

- If A reacts by break off, acceptance or rejection, we shall have similar consequences as those described above for the affected participant B (see B1, B2 and B5). In every case B gets information about the decision of A. If A rejects, the question arises whether the negotiation is continued or terminated. This must be regulated by the process of configuration. The rejection of a rejection is especially unreasonable in most cases; yet in some situations it might be sensible that A has a chance to explain his or her intention by a comment and to ask B for a new decision.
- A must have the possibility to modify B’s modification or — if B has rejected — A may offer a modified proposal of his adaptation hoping that this will meet with B’s acceptance. A can also accept until withdrawn. If this is a reaction to a rejection we have the consequence that A can repeat the negotiation on another occasion. The
possibility of withdrawal should not be available if B has already accepted until withdrawn, otherwise the situation becomes very confusing.

**Table 3) Example**

Supposing we have a WMS which is forwarding a specific class of cases (represented by documents) from A to B to C. A, B and C might be persons or roles. Now A feels that B is a specialist in these cases and would be able to preselect the cases. Therefore A intends to change the sequence, so that B firstly receives the documents. He tries to manipulate a graphic representation of the sequence which is accessible by the system. Now the negotiation starts and B is informed. He or she might break off and immediately pick up the phone to discuss the problem. By contrast, B might have had the same idea and accepts. In this case the sequence is changed or a member of the management will be involved in negotiation, as it might be configured for every modification of sequences. B might wish A to receive a copy of the document (representing the case) at the same time as the document is forwarded to B. This is a modification which causes a continuation of the negotiation. A might reject this modification and B has to decide again. If they do not find a compromise, the configured option will be activated. This option can be represented by the following rule: Adaptation of sequences has always to be accepted if the activator has a higher hierarchical position than the affected participant, otherwise sequences have to remain unchanged.

It can be understood that negotiability requires a lot of preparation in the process of configuration. Functions, documents and other objects must be classified and it has to be decided — according to this classification — whether an adaptation should be negotiated and when the negotiation should start and who should be involved. The configured options must be determined and the maximum number of loops must be specified. Furthermore it has to be decided how long an activator must wait (in the case of rejection) until he is allowed to propose the same adaptation a second time. In addition, a deadline must be specified after which the configured option is chosen, if one of the negotiators refuses to react.

By working out this concept we understood that there are some considerable difficulties remain which we have to overcome:

- Serious problems arise if more than two or three participants have to take part in the negotiation. In this case, rules have to be found to manage the sequence of negotiations or to reduce the number of negotiators. These rules cannot be general because they have to be in strong relation to the aims and organizational structures of the company which is using the WMS.
- Our choice between acceptance or rejection might be too simple. In many cases the possibility for a rating on e.g. five levels might be more comfortable especially if more than two persons are participating. Opportunities and problems which are related to rating have been analyzed in the case of meeting schedulers (EPHRATI [3]).

**Further perspectives: Who will use negotiability?**

The important question is whether negotiability will really be used or not, if it is brought in practice. The answer mainly depends on the way it is introduced and offered. We assume that an adaptation is rather a subject of negotiability than a control decision (compare fig. 1) because it affects a greater amount of cases. First of all, the effort of negotiation must not exceed the effort which would be necessary to deal with the situation being established if an adaptation happened without negotiation. Achieving this aim depends on several factors:

- Ergonomical interaction modes must be offered to use adaptability and negotiability
- Users must be qualified to use these concepts.
- Managers should accept the dynamism of technical support related to organizational structures and they should motivate employees to contribute to adaptation.

People using negotiability might be

- users of WMS who want to adapt the system and on the other hand wish to be sure that conflicts with other users, who might be negatively affected, are avoided.
- delegates of the management whose responsibility it is to survey the consistency and efficiency of organizational structures and technical support.
- persons who frequently wish to improve technical means also in those cases where others are directly affected.
- persons who, in most cases, will choose the acceptance button if an adaptation is proposed but who want to be asked before something is going to be changed.

We received some empirical evidence that negotiability might be helpful by questioning 87 employees from different companies. We asked the interviewees' ratings differ;
this was expected. This result is not proof that negotiability will really be an advantage in the situation of daily working life, but a hint that the effort of introducing this concept might be worthwhile. The investigation is documented in RHODE [14,15].

Table 4) Scenarios
We had two scenarios describing the following situation from the perspective of an activator (A) and of an affected user (B) of a WMS: A has changed some data on a document; afterwards the document is forwarded and is actually assigned to the working area of B. Now A wants to change a value he has put in and therefore tries to access the document. In the case of these two scenarios A has total control and can have access whenever he likes if the document has not actually been opened by B. We also described other scenarios which offered more transparency and moreover the possibility of negotiation in some scenarios — always from two perspectives: the active and the affected user. We tested the hypotheses that there are conflicts between the judgements of A vs. B scenarios in the case of total controllability (1) and that these conflicts disappear when negotiation is possible (2). The interviewees had to rate five aspects: acceptance, support of work, degrees of freedom, stress and time needed.

Even if negotiability were never used to make a break off, modification or rejection, it would be useful in a psychological sense because it is an advantage to know you will have the opportunity to use your veto in the case of an exception. One serious reason not to use negotiability is given if persons who would like to adapt or to negotiate something are hierarchically dependent and do not dare to become active. On the other hand, in the case of WMS one main advantage of negotiability is that it enables a participatory adaptation and improvement of technological, as well as organizational structures, in a way in which both sides are integrated.

Bibliography
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