

## **AN EARLY EVALUATION OF TECHNICAL MECHANISMS SUPPORTING NEGOTIATIONS IN GROUPWARE**

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**ABSTRACT:** A set of design principles for groupware will be proposed. As some of these principles conflict with each other, a "suitability for conflict regulation" will be introduced as an additional principle which proposes to design groupware so that users can regulate conflicts among themselves. According to this principle, we propose negotiability as a technical mechanism to support users regulating conflicts on the activation of a function. To evaluate negotiability empirically, we developed a scenario-based questionnaire. The results of this evaluation-study will be presented and discussed.

**RESUME:** Nous proposons un ensemble de principes de construction de groupware. Car quelque principes sont en conflit l'un avec l'autre nous proposons "l'appropriété pour la régulation des conflits" comme une principe supplémentaire. Ce principe demande de construire les applications dans une façon que les utilisateurs peuvent régler les conflit parmi eux. Nous definons une certain class de mechanisms qui s'appelle "negotiabilité". Pour l'evaluation emirique des effets de negotiabilité sur le proces de la régulations des conflits nous avons inventé une questionnaire qui présente des scenarios differentes aux interrogés. Les résultats de cette étude empirique sont présenté.

## 1. INTRODUCTION

With single user applications, there exists a set of principles for a human centred design. The principles suitability for the task, self descriptiveness, controllability, conformity with user expectation, error tolerance, suitability for individualization and suitability for learning are currently in the process of international standardization [cf. ISO 93]. These design principles are derived from an empirical study on requirements that computer users regarded as important for the quality of interactive systems [cf. Dzida et al. 78]. The results of this study were introduced in the process of German national standardization [DIN 66234, Part 8]. Nowadays these principles are widely accepted. They have been used as a basis for guidelines to evaluate computer applications from a human-computer-interaction point of view [e.g. Reiterer & Oppermann 93].

In this paper we will deal with groupware. Contrary to single user applications, where individual users only interact with the system, groupware supports the cooperation and communication among different users. Thus, the design principles have to be modified to suit to this new field of application. For this purpose, we will propose a set of design criterias for groupware. To perform an early evaluation of these criteria, we have developed a scenario-based method. We will present this method to evaluate technical mechanisms which have been designed according to one of the principles called *suitability for conflict regulation*.

## 2. SUITABILITY FOR CONFLICT REGULATION AS A DESIGN PRINCIPLE FOR GROUPWARE

The discussion in the field of human computer interaction has not yet developed a stable set of design principles for groupware. Here we will propose such a set of principles. These principles have been developed based on:

- software-ergonomic design principles for single user applications
- design requirements resulting from the German discussion on informational and communicative self-determination rights which are based on constitutional guarantees
- an analysis of literature on the problems of using network systems
- two empirical case studies on problems of cooperation and communication within the context of using networked systems.

Figure 1 gives an overview of the design principles of groupware compared to those of single user applications.

The single design principles are discussed in detail elsewhere [cf. Herrmann et al. 96].

Although the basic structure of the catalogue of principles for single user applications and for groupware is similar, there is a distinct difference. The design principles for groupware are partly conflicting with each other. Others cause conflicts when they will be interpreted from users having different points of view. This is indicated by arrows in figure 1. These arrows express the fact that different users might have diverging or even conflicting interests [cf. Schmidt 91, Easterbrook et al. 93] which might lead to different requirements concerning the design of certain functions.

For instance, the principle *visibility* demands that technical features generate and display automatically data which support users to become aware of other users' action (visibility of use) or which allow to explore the system's functionality (visibility of function). Ethnographical studies in the field of CSCW gives empirical evidence on how important it is to be aware of the cooperation partner's activities [cf. Heath & Luff 91; Bowers 94]. They indicate the importance of visibility of use. To support users in handling local contingencies, Dourish [95] proposes to equip an application additionally with a reflective behavioural model ("an account") which allows users to observe a systems state and to explore relevant aspects of a system's functionality. The implementation of these accounts increases an application's visibility. Thus, the principle of visibility expresses the perspective of groupware users which suffer from a lack of information about the functionality and state of an application. It demands the generation and display of data which might violate other users privacy.

<b>Design Principles for Single User Applications</b> (ISO 9241 PART 10)	<b>Design Principles for Groupware</b> (according to: Herrmann, Wulf and Hartmann 1996)
Suitability for the Task	Suitability for Information - Contextuability - Referenciability ↔ Moderability - Structurability
Self-Descriptiveness	Visibility - visibility of function ↔ Moderability - visibility of use
Conformity with user expectation	Controllability of Interactional Influence - Controllability of personal access ↻ - Controllability of distribution ↻ - Controllability of access ↻
Suitability for Learning	Group Specific Error Tolerance ↻
Controllability	Group-oriented Configurability
Error Tolerance	Suitability for Conflict Regulation
Suitability for Individualization	

Figure 1: Overview of Design Principles

By contrary, the principle *moderability* suggests a technical design which allows users to reduce the amount of data generated and displayed. This principle expresses the interest of users not to make all their private information public (e.g. for privacy reasons). The importance of this design principle has been worked out by recent CSCW-research, too [cf. Belotti & Sellen 93; Wulf & Hartmann 94; Clement & Wagner 95]. Similar contradictions exist between other design principles (*suitability for information* vs. *moderability* and *controllability of personal access* vs. *controllability of distribution*) and even within single principles if they are interpreted from different points of view. For instance, "controllability of access" on shared data can lead to conflicting requirements among the users involved.

Rather than indicating adequate solutions to the design problem of certain functions, these conflicting principles demand an implementation of a variety of functional alternatives. Users should have the chance to choose the adequate one according to their specific work context. Such a choice of functional alternatives can happen either during a system's configuration or during a system's usage. In both cases the choice of functional alternatives may lead to conflicts [cf. Cool et al. 92]. Therefore, a groupware application should provide support for users to regulate conflicts on the choice of functional alternatives before and during system's usage. Conflicts can be regulated in different ways. In this paper we will assume that conflicts should be regulated by negotiations among the users involved. This follows the results of social scientific conflict theory [cf. Smith & Berg 87; Dorow 78; Dahrendorf

61]. Nevertheless, this position has been criticized concerning the regulation of certain conflicts within organizations [cf. Egger & Wagner 92; Murnighan & Conlon 91].

The design principle *group-oriented configurability* asks for a design which allows to set up the system adequately for a group's specific working environment before use. If conflict regulation is based on open negotiations among the users, the configuration should happen participatively among the users involved.

Nevertheless, it will not be possible to anticipate solutions for all conflicts concerning the choice of a functional alternative before the use of the system. Therefore, we propose "suitability for conflict regulation" as an additional design principle. It demands for technical mechanisms which support users in regulating conflicts during the system's usage.<sup>1</sup> Such mechanisms are of special importance if users are not working at the same time or place because in this case patterns of conflict regulation which are based on social interaction among the users might fail.

If conflict regulation is based on open negotiations among the users, it is necessary to make the choice of a functional alternative visible, to offer possibilities for communication among them, and to allow users affected to intervene against the decision of the activator. Depending on the context of use, these requirements can be met only by social interaction, by technical mechanisms, or by a mixture of these components [cf. Dourish 93]. A classification scheme for technical mechanisms which support conflict regulation has been developed [cf. Wulf 95 and 96]. Figure 2 presents this classification scheme. Depending on the fact whether the right to intervene, visibility of activation, or the communication channel are realized by technical means, different classes of technical mechanisms can be distinguished. In this paper we will restrict our attention to one class of mechanisms (called *negotiability*) which realizes all features mentioned above by technical means. We will compare the application of these mechanisms with a situation where there is not any technical support for conflict regulation (controllability). These classes of mechanisms are marked with a grey colour in figure 2. Results of a comparison between mechanisms which only make the choice of a functional alternative visible (visibility of activation) and controllability have already been presented [cf. Wulf & Rohde 96].

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<sup>1</sup>Note that in an earlier paper we restricted our attention to negotiability as a specific class of mechanisms for conflict regulation (cf. Herrmann, Wulf and Hartmann 1996).

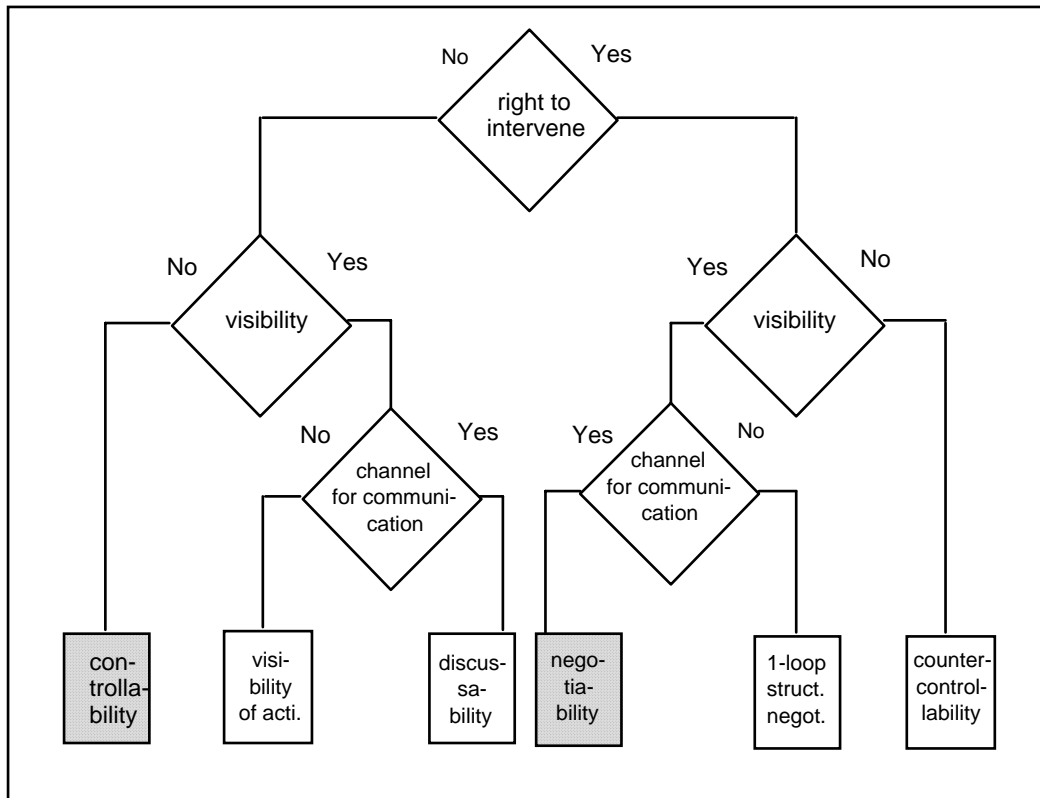


Figure 2: Classification scheme for technical mechanisms to regulate conflicts in groupware

To work out the concept of negotiability and to evaluate its effect, we use the concept of roles, which describes the position held by a user in a technically mediated interaction. We distinguish the role of the activator of a function from that of the user affected by the activator's choice.

### 3. NEGOTIABILITY AS A STRATEGY FOR CONFLICT REGULATION

Negotiability supports the regulation of conflicts between activators and users affected by making the activation visible, offering a technical channel of communication, and allowing users affected to intervene against the decision of the activator by technical means. The channel of communication is opened just in the moment when a conflicting activation of a function occurs and it is closed down when the technically supported process of negotiation is finished.

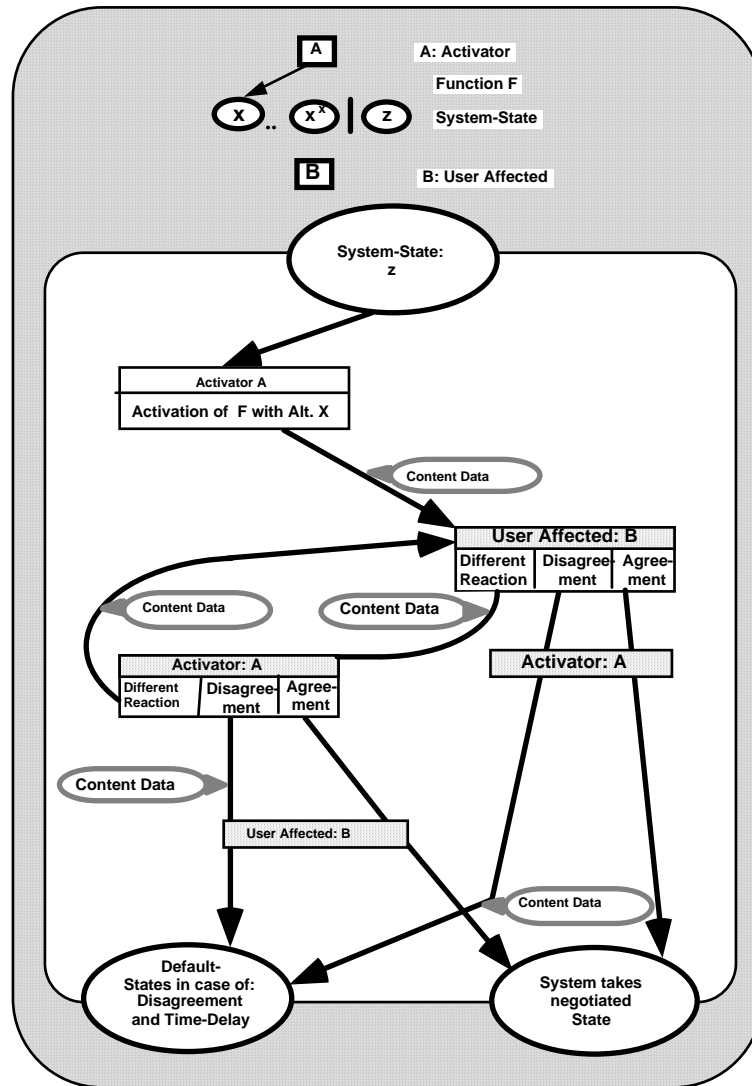


Figure 3: Activation of a function on the level of structured or semi-structured negotiability

As conflicts concerning the activation of functions may cover various topics, different implementations of the communication channel seem to make sense. Here, we distinguish *structured* from *semi-structured* versions of this mechanism. Both of these versions are based on an understanding of communication which has been worked out in the speech act theory [cf. Austin 76]. The communication among the users consists of an exchange of predefined acts of negotiation like proposal, agreement, disagreement, and counter-proposal. Although the application of this theory for the design of general purpose communication systems like the Coordinator [Winograd 88] has been criticized [cf. Herrmann 91, Suchman 93], this approach seems to be interesting for the resolution of conflicts caused by the activation of certain functions of groupware because it allows to communicate efficiently in a timely way.

In case of structured *negotiability*, users can exchange acts of negotiation, which merely indicate their type and the functional alternative selected (cf. figure 3). *Structured*

*negotiability* does not allow users to exchange more information (e.g. give reasons for their decision) but it is very efficient from a time standpoint (as input can be made by just pushing buttons on an input device). The activator who intends to use a function opens up a channel by which the affected user is informed about the activator's choice. This is indicated by the underlying grey colour in the user's affected box in figure 3. The affected user can either agree or disagree to the proposed alternative. If he agrees, the activator will be informed about it (grey box in figure 3) and the jointly chosen alternative will be executed by the system. If he disagrees, a default option, which has been selected in advance during system configuration, will become active. Furthermore, the user affected may have more possibilities to react. For example, he could be able to express a counter-proposal. In this case, the activator will be informed about it (grey colour in activator's box) and has the chance to respond to the affected user's reaction by transmitting similar acts of negotiation. In case the user affected gets involved only once in the negotiation process, we speak about *single loop negotiability*. If the user affected gets involved for a second time, we speak about *double loop negotiability*.

As negotiation processes in general have to be finished within certain time limits, it should be possible to predefine another default-state in case the reaction of users exceeds certain time limits.

We speak about *semi-structured negotiability* when users additionally get an opportunity to add non-structured content data to each act of negotiation. Such content data may consist of a field of non-structured text or an additional voice channel which will be connected to single acts of negotiation [cf. Wulf 95a]. The option to include content data to the individual acts of negotiation is indicated by grey ovals in figure 3.

In the following we will evaluate empirically whether structured or semi-structured negotiability can support users in regulating conflicts concerning the activation of a function. Note that single loop structured negotiability does not offer a technical channel of communication among the users (cf. figure 2). Therefore, we will not investigate this type of negotiability in this paper.

#### **4. HYPOTHESES**

We assume that the communication channel provided by *negotiability* would reduce conflicting interests among users. To test this assumption we looked at certain functions of groupware where different users were supposed to have conflicting interests. As an indicator for conflicts of interests among users, we used differences in their subjective judgements on certain groupware functions.

Thus, we assumed that applying negotiability to flexible groupware functions reduces these conflicts of interests among end users holding different roles.

Hypothesis 1:

The introduction of negotiability reduces the differences in subjective ratings.

Furthermore, we were interested in the over-all judgement of the users regardless their role. We hypothesized that end users in general would prefer the usage of negotiability compared to a situation where only the activator can decide on the usage of flexible functions.

Hypothesis 2:

Negotiability is rated higher than controllability.

## 5. EMPIRICAL DESIGN

We had to find a method for the evaluation of design principles which were derived from conceptual considerations which were not yet widely put into praxis. We wanted to question as many end users as possible not in an artificial, experimental laboratory situation, but in their own well-known everyday work context. Furthermore, we wanted to get users from different organizations involved in this study. In different organizational contexts it was neither possible to install a single prototype realizing negotiability nor was it possible to intervene directly in the end users' work environment. On the other hand it was necessary to develop a method by which we could survey judgements on one specific technical option in relation to a range of other possible options to test specific design principles against each other.

Traditional exploratory approaches in *software engineering* context often use methods like mock-ups [cf. Ehn & Kyng 91], simulations and 'throw-away'-prototyps [Bødker & Grønboek 91, 199], or 'experimental prototyping' [cf. Floyd et al. 1989]. In the reported cases these artefacts are used as media for communication between engineers and users during participatory development processes [cf. Bødker & Grønboek 91]. By contrary, in our study we wanted to evaluate already defined design alternatives which differed strongly in their dynamic behaviour. Their graphical presentation by means of screen shots would have been less expressive than using natural language.

In technology assessment the scenario technique was developed to allow the analysis of relationship between technical and social developments [cf. Bech 90, 112]. Nardi emphasizes the narrative character of scenarios and describes a basic scenario, which "should be one or two pages long, though it might contain appendices with further detail and clarification" [Nardi 92, 14]. Within HCI-research Campbell [92] proposed a categorization of different scenario-based techniques. These proposal caused a discussion among the HCI-community [cf. Kyng 92, 8].

In contrary to the most approaches, we used short scenarios as very brief descriptions of

technical design options in the context of everyday work situations. Therefore, we decided to run a field study with a questionnaire in the interviewees' daily working environment. The subjects were assigned to different questionnaire-versions (corresponding to different experimental conditions) at random. These versions of the questionnaire contained specific sequences of short scenarios in which we operationalized our independent variables (technical conditions, roles of interaction) [cf. Rohde 95].

We developed an empirical design which consisted of two areas of application. In each of these areas of application we operationalized three technical conditions. Indeed, we operationalized three more technical conditions because we were looking at the effects of other mechanisms for conflict management, which were not relevant for this paper [cf. Wulf & Rohde 96].

At first we expressed a situation where a flexible function was fully under the control of the activator (controllability). Furthermore, we described two variations of *negotiability* (*semi-structured single loop* and *structured double loop*). As we were interested to investigate conflicting interests resulting from different roles, we described each technical condition in both of the areas of application from both perspectives: the one of the activator and the one of the user affected.

To create a comparable situational context of interaction at the beginning of our questionnaire, we offered the same *basic situation* to all interviewees. We asked the subjects to put themselves in the position of an office worker (in an administration) with a telephone and a networked computer-terminal at their workplace. They had to work on office procedures and their tasks had to be fulfilled according to schedule.

We had performed an exploratory study before to ascertain that employees in administration were rather familiar with these working conditions. As one field of application we chose problems resulting from conflicting demands to access documents in an office procedure. Such conflicts have been found by Kreifelts et al. [91]: Testing an office procedure system which supported the process of purchasing equipment in a research institute, they reported that, "the strict input/ output relations between the actions of a procedure do not allow the data produced in one action to be changed in a subsequent action. .... This was a source of much discussion and we had to employ a work-around for some cases" [ibidem, pp. 126].

Thus, our first field of application can be described as a working situation of rigid access control. Having mailed a document, the sender cannot regain access for this document in order to do necessary corrections. On the level of *controllability*, the sender, qua activator, gets technical support to reaccess the document after having sent it. On the level of *negotiability*, the user affected gets information about the sender's activities and is also given technical opportunities to negotiate on and to intervene against the sender's access.

To clarify our method, we will present the two scenarios describing the level of *single-loop semi-structured negotiability* as well from the perspective of the activator as also from that of the user affected.

During your work you notice that you have to reaccess an office procedure on which you had already finished work. You made it already available to the next colleague who is responsible now. If you need to reaccess this document you can type a free style text which will be displayed in a window on your colleague's screen. After having received your demand, your colleague can decide whether he permits you to reaccess the document or he can use a similar window to explain why he does not allow access right now.

Scenario: Office procedure on the level of single-loop semi-structured negotiability  
(role of the activator)

Processing an office procedure in its regular sequence, it is up to you to work on it. If one of your colleagues wants to reaccess this document beyond the regular sequence (e.g. because of additional processing) this will be indicated to you via an opening window on your screen by which your colleague can express his demand and give reasons for it using free style text. Now you can either allow him to access the document or you can use a similar window on his screen to explain why this is not possible right now.

Scenario: Office procedure on the level of single-loop semi-structured negotiability  
(role of the user affected)

On the level of *double-loop negotiability*, the sender has the chance to insist on his demand by sending a second structured message to the recipient which indicates that his demand is urgent. In this case, the recipient has the option either to agree or to disagree. In case of disagreement, he can commit himself to allowing the sender access after a certain time.

The second field of application deals with conflicts related to disturbances caused by incoming telephone calls and the flexible cut-off function. As we had found out in an exploratory study [cf. Kahler 94], office workers complained on the one hand about the frequency of disturbances by incoming phone calls but on the other hand they had problems to get hold of colleagues they called. The scenarios in this field of application were constructed similar to the office procedure scenarios which were described above.

In the case of *single-loop semi-structured negotiability*, the caller can explain his demand to deactivate the recipient's cut-off function by a one-way voice channel. The caller can either accept the call or, when refusing it, he can send a short explanatory voice message. On the

level of *double-loop structured negotiability*, the caller gets the chance to repeat his demand if the recipient has not responded positively to his first attempt by pushing the button again. In the second loop of negotiation the recipient can respond by reducing the duration of his cut-off.

These scenarios represent just an excerpt of our total pool. Out of this pool we constructed questionnaires. Each of them consisted of two blocks. The first block described all functional levels of the first area of application taking the perspective of one role. The other block was taken from the second area of application using the same method of selection. This combination led us to four different questionnaires. To avoid effects resulting from order of the scenarios we arranged them at random within each block.

We asked the interviewees to judge each of the scenarios presented according to five dimensions which were derived from concepts in work psychology [cf. Hacker 86, Volpert 90, Ulich 91]. These dimensions were:

- acceptance (of given conditions of interaction),
- facilitation (of the conditions for their task),
- individual autonomy (the situational conditions offered for interaction),
- the mental workload (the situational condition causes) and
- the (subjectively estimated) time needed (for the task under the conditions given).

Each dimension had to be answered on a scale of four [cf. Rohde 95].

## **6. EMPIRICAL RESULTS**

We distributed 488 questionnaires to six private companies and one public administration. We received 89 answered questionnaires at a return rate of 18.24 percent. The rather low response rate might be caused by the size of the whole questionnaire (15 pages) and its purely text based layout (cf. previous chapter). However, this response rate is not unusual for social scientific studies. 68.5 % of the subjects answering the questionnaire had experience with networking as end users, 11.2 % as system administrators. 79.7 % of the participants in our study were familiar with our basic situation of an office worker equipped with a networked computer-terminal and working on office procedures.

First of all we tested the main and interaction effects to exclude potential sources of interference (e. g. sequence-effects) by a MANOVA-procedure (2x2x5 with repeated measures on the third factor *functional level*). The main effect *judgement* is highly significant for all five dimensions (Pillais Trace test scores with  $p < 0.0005$ ), the interaction effect *judgement x role* is highly significant for all five dimensions, the effect *judgement x field of application* is significant for the dimensions acceptance, facilitation, workload, and time

needed. The analysis of variance does not show any significant order- or *sequence*-effects [cf. Rohde 94, pp. 163].

Furthermore, we computed ANOVAs in order to test our first hypothesis. We computed role-effects concerning judgements about *controllability* and compared them to role effects on the levels of *negotiability*. We ran ANOVAs first for the judgements on *controllability*, then for the aggregated judgements on *negotiability*. In the case of *controllability* we found significant interaction effects which disappear in the case of the *negotiability* conditions. Only the effect on the acceptance-scale is significant. These results are presented in Table 1 (A probability using a F-test  $p < .05$  means a significant result,  $p \geq .05$  means that there is not a significant effect).

	controllability				negotiability			
	N	DF	F	p(sig/F)	N	DF	F	p(sig/F)
acceptance	173	1	10.943	0.001	173	1	5.951	0.016
facilitation	172	1	35.378	<.0005	172	1	2.645	0.106
autonomy	171	1	18.817	<.0005	171	1	2.707	0.102
workload	172	1	34.973	<.0005	172	1	2.186	0.141
time needed	170	1	59.492	<.0005	170	1	0.042	0.838

Table 1: ANOVA results: conflicts of interests concerning controllability and negotiability

Regarding hypothesis 2, we computed differences in judgement between *controllability* and the two types of *negotiability*. Every negative difference reflects an equal or better judgement for the *controllability*, every positive difference means a better judgement for negotiability. Subsequently we tested all the negative against all the positive differences with the chi-square-test.

Table 2 demonstrates the results of the chi-square-tests comparing aggregated judgements on *negotiability* (structured double loop and semi-structured single loop) with the judgements on *controllability*. Looking at the whole sample, we find a preference for *negotiability* on the first three scales (acceptance, facilitation, autonomy) but not for the workload- and the time needed-scale. This result hints to the fact that potential users expect that negotiability will facilitate their work and will increase their personal autonomy but, but on the other hand, that it will cause higher workload and higher effort of time needed. Nevertheless, the over all acceptance of negotiability is highly significant.

	negotiability vs. controllability			
	N	Chi <sup>2</sup>	DF	p (sig/Chi <sup>2</sup> )
acceptance	173	30.8035	1	<.0001
facilitation	172	18.2326	1	<.0001
autonomy	171	40.2865	1	<.0001
workload	172	2.3256	1	0.1273
time needed	170	0.0941	1	0.7590

Tab.2: Chi-Square-Results: controllability vs. aggregated negotiability scenarios

## 7. DISCUSSION

Our results demonstrate, that there are conflicting interests regarding the situational use of groupware functions and that these role-differences could be reduced by technical means. In the fields of application investigated in our study, *negotiability* seems to be a useful means for reducing role-based conflicts and for increasing overall acceptance. We assume that besides telephone and office procedure systems, this design principle is meaningful for other groupware applications, as well. Whenever a function affects more than one user and the resulting conflict should be regulated by negotiations among the users involved, the application of *negotiability* should be considered. It seems to be of special importance if there are not any other channels of communication among users to cope with role-based conflicts. This is often the case when groupware is used locally distributed or asynchronously. Furthermore, the *negotiability* seems to cause additional workload and need more time than usual. Therefore the design principle should be realized with respect to the users' specific interests.

Choosing a questionnaire we were able to operationalize design options for both of the roles (activator and user affected) and for two different areas of application (telephone cut-off function and access in a workflow system). Nevertheless, our findings are based on scenarios which might affect their external validity. The users had to imagine the working conditions and to anticipate their behaviour. Thus, they could not experience the emotional aspects of using the different technical conditions presented. Therefore, our findings should be checked in further studies with additional empirical methods. After *negotiability* will be implemented in widely used applications, alternative studies with different empirical methods will be possible. Such an implementation will be our next step. In a current project we implement negotiability in a groupware application being used in the public administration. Thus, we will be able to check the validity of the findings presented in this study.

The scenario-based method we have developed for our study permits to evaluate concepts at a very early stage of a design process involving different users. We operationalized negotiability by scenarios expressing technical design options in two fields of application. Beyond this, the scenario-based questionnaire could be used to check new design ideas in other contexts. It takes role-based effects into account and offers a method for a comparative analysis of different design options. If users get involved in the construction of the different scenarios, such a questionnaire could be used for instance as a means within a cooperative design process which involves many users in large organizations.

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