Beyond Formal Processes: Augmenting Workflow with Group Interaction Techniques

Pedro Antunes, Nuno Guimarães,

Instituto Superior Técnico
INESC
R. Alves Redol 9
1000 Lisboa, Portugal
{paa,nmg}@inesc.pt

Javier Segovia, Jesus Cardenosa

Universidad Politecnica de Madrid
Facultad de Informatica
Campus de Montegancedo
28660 Madrid, Spain
{fsegovia,carde}@fi.upm.es

ABSTRACT

The main scope of workflow systems has been the automation of *formal* procedures in the workplace. On the other hand, Communication and Group Support systems have addressed the *informal* aspects of organizational interactions. We argue that the *formal* versus *informal* separation is artificial and a cause of systems ineffectiveness. This paper proposes an approach to increase mutual awareness when integrating support for workflow systems and group interaction techniques.

KEYWORDS

Workflow systems, group interaction, group decision support systems.

1 INTRODUCTION

The intensive and growing use of information technologies in the workplace and organizational settings has been a worldwide trend in the last decades. The investment in technology made by companies and institutions has however been questioned regarding its effectiveness in terms of productivity growth [7]. The management theories and practices have evolved in a scenario of coexistence between human, social and economic factors and technological possibilities [10, 13]. On the other hand, technical systems have developed towards a better match with organizational problems. Workflow systems [34, 19] are a new class of systems that address organizational activities beyond the mere automation of tasks provided by office technologies and personal productivity tools.

A parallel trend has been fostered by the increased connectivity provided by networked infrastructures, both at the workplace and worldwide levels, through local area and telecommunications networks. This trend made tools like electronic mail, electronic bulletin boards or file transfer facilities pervasive in the daily work of many organizations. Further developments have suggested the use of collaborative applications for informal processes like group decision or negotiation [16].

A global view of organizational structure and behavior is presented in [22, 21]. From this vision, we acknowledge a coexistence between formal and informal processes or flows, that are executed by the multiple components of the organizations. The complexity that arises is a fact that has to be dealt with by technical systems.

The main scope of workflow systems has been the automation of *formal* procedures, typically associated with administrative or manufacturing processes [19]. Workflow systems automate well defined sequences of actions, performed by well defined actors or agents, either persons or machines. On the other hand, Communication and Group Support systems have addressed the *informal* aspects of organizational interactions. Reusing Mintzberg's framework, workflow systems reflect formal authority and regulated flows, while Communication and Group Support systems address informal communication, work constellations and ad hoc decision processes.

As [12] states, workflow systems "...have been criticized in the literature as 'automating a fiction' in the office." The *formal* versus *informal* separation is artificial and a cause of systems ineffectiveness. Real work in real organizations is, as Mintzberg suggests and as we experience, a mixture of both formal and informal processes. Systems should be designed to increase mutual awareness and provide seamless transition between support for formal and automated procedures, and informal group processes.

Several approaches to this problem have been ad-

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dressed in the literature. Most approaches are based on the Speech Acts theory [20, 2, 1, 6, 35] but other approaches include Goal Based models [12], Semi Structured Messages [30] and Circulation Folders [15].

The above approaches suggest several technical solutions to the seamless integration of workflow and group interaction with flexible and dynamic transfer of control between different types of processes. One further development that we consider in this paper consists in, prior to transferring control, collecting key information from the formal system and use it to influence the informal system progress such that some added rationality emerges (methodology). The expected positive influence is suggested from sociology and management sciences theories and methodologies concerning effective decision making. From a technical standpoint, our intention is to preserve the degree of independence between both types of processes.

Our approach can be summarized as follows: the workflow system must be able to identify situations where formalized solutions do not exist. Once identified, and categorized as a *problem* to be solved through an informal interaction, several group interaction techniques are available to support that interaction. A match between problem characteristics and available group interaction techniques has to be found. Once this match is found, the informal process is activated through the activation of the computer-based tool that supports the selected technique. The outcome of the informal process is fed back into the workflow system that is then able to progress with the execution of the formal flow.

The structure of the paper is the following. First, we give a general view of the logical architecture, based on the Workflow system and the Negotiation system. In section 3 we address the issue of matching problems with group interaction techniques. Sections 4, 5 and 6, are devoted to the description of the Negotiation system, and are followed by the conclusions.

2 GLOBAL ARCHITECTURE

The work presented in this paper is being carried out in the scope of a larger project called ORCHESTRA [1]. The Workflow system is a major component of the ORCHESTRA platform which provides the ability to manage, monitor and control the execution of organizational procedures. The system functionality includes: storage of generic flows, creation of processes, process tracking, process archiving, parallel processing, exception and time-out triggering, integration with office environment tools (editors, spreadsheets, etc) including launching of new tasks and notification of task completion. The Workflow system runs on a distributed platform with support for security, authentication and replication (to increase performance and availability).

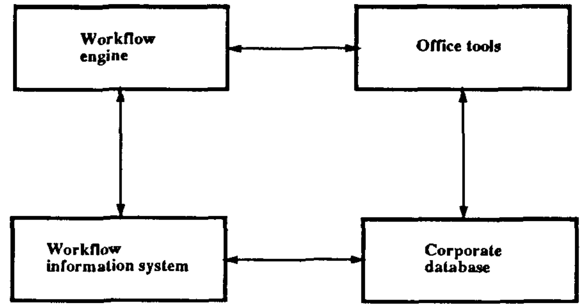

Figure 1: The Workflow system.

The Workflow system itself is based on a flow management engine and on an organizational description. The Workflow engine is dedicated to support and maintain the above functionalities while the organizational description is used to specify the flow information, i.e. flow context, entrance actions, departure actions, conditions and alarms. The internal model of the Workflow engine is based on Petri Net formalisms [27]. The organizational description is generated after a process of informal organizational diagnosis performed by experienced social sciences experts, which becomes formalized through specification mechanisms provided by interactive specification tools [2].

The global architecture of the Workflow system is depicted in figure 1 and shows the Workflow engine, the office tools, the external corporate databases, and the Workflow information system. The organizational description is conceptually stored on the Workflow information system.

2.1 Workflow and Group Interaction

The Workflow system described above is able to detect alternative situations in the execution of organizational procedures. The alternatives correspond to several scenarios of a same procedure. For each procedure, and whenever it is technically and theoretically possible to identify all the scenarios (including the ones resulting from expected exceptions), the Workflow information system provides a description of the several steps associated with the execution of the procedure, and the Workflow engine is qualified to automatically handle the possible scenarios. It should be noted that the several scenarios associated with a procedure may consider *irregular* situations from the organizational point

[1]Partially funded by the Commission of the European Communities, under ESPRIT contract 8749. ORCHESTRA stands for ORGanizational CHange, Evolution, STRucturing and Awareness.

[2]The approach is based on the use of object oriented and role based CASE tools. The description of their use is however out of the scope of this paper.

of view. As long as these *irregularities* are formally defined, their handling is automatic.

However, a definition of all possible *irregularities* is impossible to produce, in an environment where the flows of information and control are often informal, the norms are not completely specified or the structure of the organization is changing. The organizational diagnosis does not identify all possible scenarios for a given procedure and will not provide solutions to all the problems that may arise in the workflow process.

This reasoning leads to conclusion that workflow automation has to be complemented with the inclusion of one level of informality to allow human intervention, and more specifically, group intervention. Therefore, we assume that unexpected exceptions that may arise will be resolved in a cooperative way.

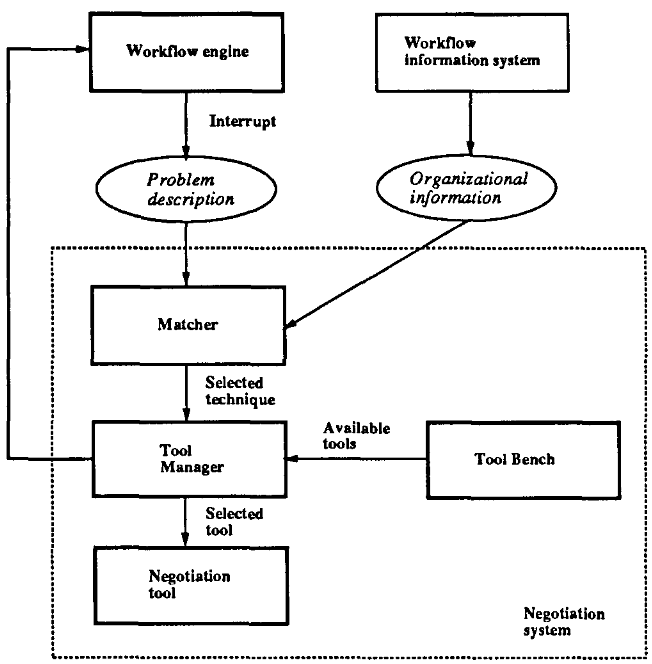

Figure 2: Global Architecture.

The architecture that supports these concepts is depicted in figure 2 and performs as follows: First, the Workflow engine detects an exception during the execution of an organizational procedure. Assuming that it is not able to handle the situation, it gathers all the available information concerning the exception and generates a *flow interrupt*.

In our pilots' Workflow systems [3] we have identified the following classes of problems that may lead to flow interrupts:

- Insufficient data
- Inadequate knowledge of executor
- Unavailable resources for task execution
- Time expired
- Deficient autonomy

[3]Two departments of a Portuguese power plant, the administrative office of a Portuguese Telecom holding and a department of a Spanish Electrical company.

The Workflow engine builds a *problem description* from the above classification plus information on the engine state, local pre and post conditions and involved upstream and downstream agents.

The problem description is delivered to the Negotiation system which handles the situation through cooperative techniques and tools. When the problem that raised the interrupt is solved, the Workflow engine may continue with the execution of the procedure.

The Negotiation system is composed by the Matcher, the Tool Bench and the Tool Manager. The Matcher receives interrupts from the Workflow engine and is responsible for gathering the relevant information provided by the Workflow information system. Based on this information, it identifies/classifies the problem and the most adequate actors to solve the problem, selecting one group interaction technique and delivering that information to the Tool Manager. The Tool Manager instantiates a tool from the Tool Bench and connects the agents with the tool.

The Matcher identifies the problem and chooses the most appropriate agents and techniques based on a set of decision criteria. The Tool Bench is equipped with tools that support cooperative techniques for informal group communication, negotiation and decision making.

3 CRITERIA FOR PROBLEM-MATCHING TECHNIQUES

This section is dedicated to provide background information and delineate the required functionalities of the matching between problem characteristics and group interaction techniques. The proposed functionality consists in the selection of techniques based on matching the information relative to the problem with the suitability of each technique for solving a particular class of problems. The matching must be based on the reasoning about the problem and the techniques at hand, i.e. according to several defined criteria, and on the model that glues together that information.

The characterization of the problem is strongly dependent on the quantity and quality of the information available from the Workflow system. This information can be divided in two types: the technical data concerning the execution and interrupt of the flow, i.e. the agents, resources, documentation, flows, time; and the

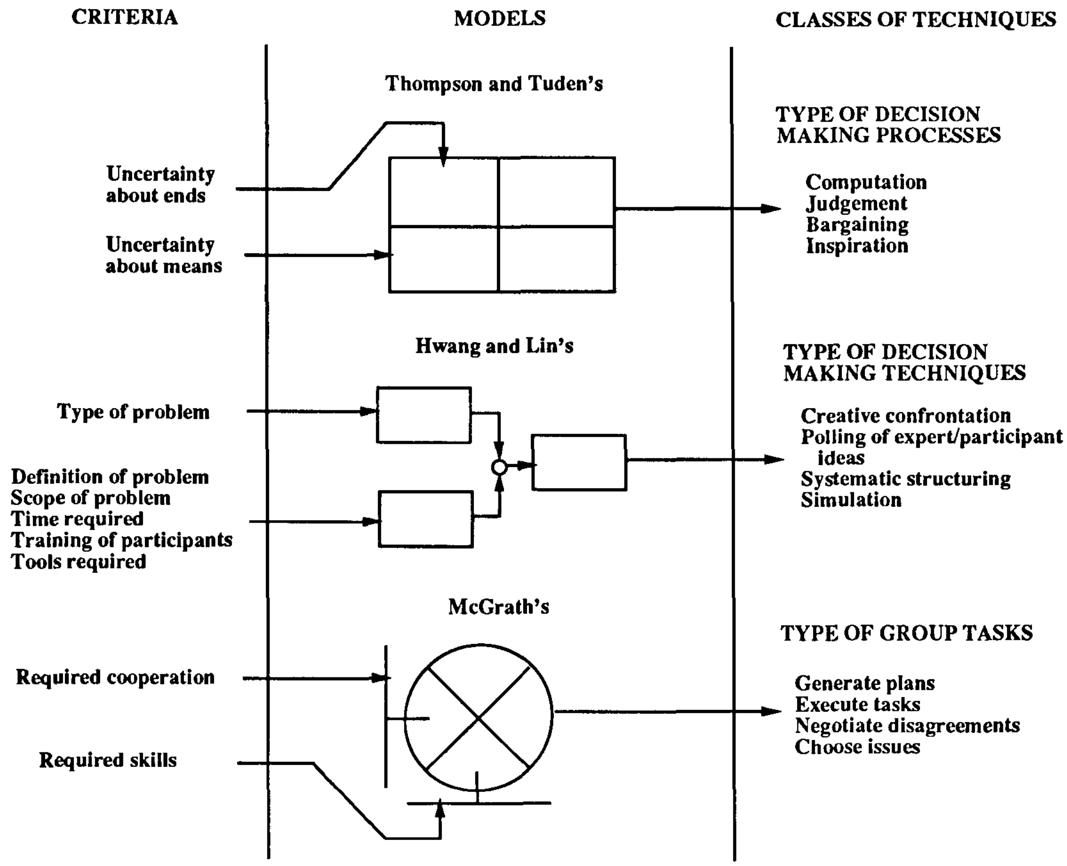

Figure 3: Criteria for Problem-Matching Techniques.

information related with the organization: the organizational structure, flows of information, hierarchies of power, formalized procedures.

Some examples of techniques for group interaction are: Brainstorming (free-wheeling idea generation) [25, 14, 24], Nominal Group Technique (structured group consensus) [31, 14], Cognitive Maps (representations of person's beliefs) [5, 11], Delphi (generation of suggestions and clustering of alternatives) [32, 28], Interpretive Structural Modeling (structuring of collective knowledge) [18], Dealmaking (mediated negotiations) [17]. A more complete catalog of the different techniques identified in the literature has not been included in this paper. Nevertheless, the above examples suggest the intended goals.

In order to develop our approach, several models that focus on organizational decision making and participation were selected. These models identify various criteria concerning both the problems and techniques and provide guidelines for problem-matching under various organizational, group and individual assumptions.

The following models were considered:

- Thompson and Tuden's contingency model for group decision making [8].
- Hwang and Lin's systems approach to expert judgments/group participation [14].
- McGrath's typology of group tasks [23].
- Vroom and Yetton's contingency model of participation [33].
- Stumpf, Zund and Freeman's contingency model for group decision making [23].

These models were chosen due to their relatively different focus on several aspects associated with group interaction, namely, the decision processes, the supportive techniques for decision making, the tasks demanded to the group, the group members expertise and the required group interaction. Other models identified in the literature, e.g. the several ones discussed by [16] and [9], cover the same range of aspects and have not been considered.

Figures 3 and 4 provide a general view of these models in terms of the used criteria and discriminated classes of techniques.

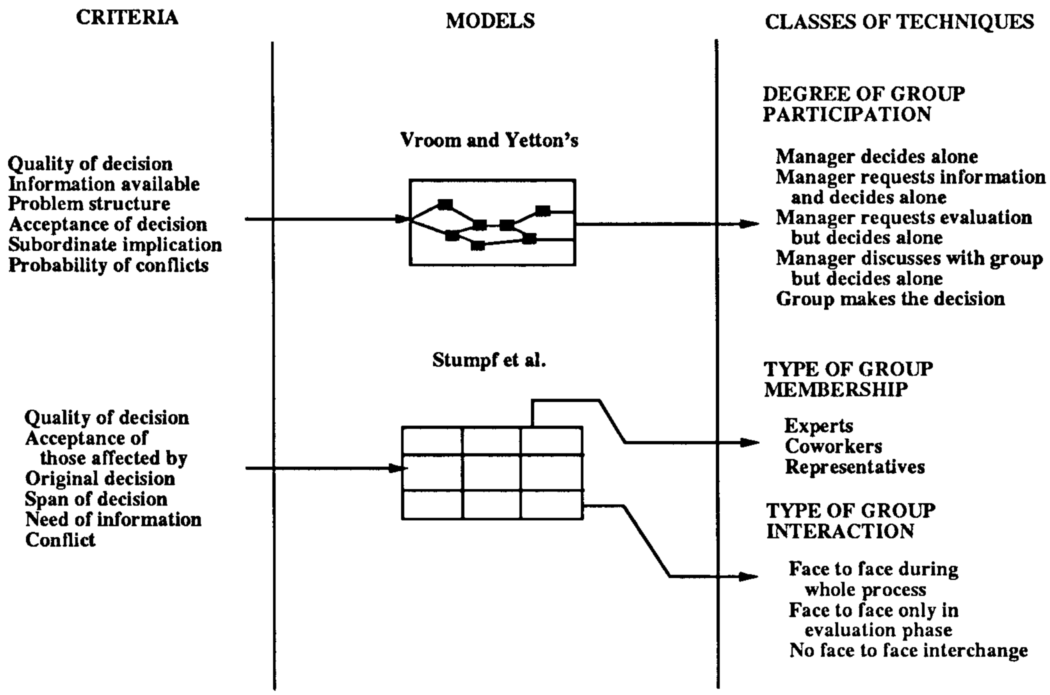

Figure 4: Criteria for Problem-Matching Techniques (continued from figure 3).

4 THE MATCHER

The Matcher is responsible for receiving the description of a problem signaled by the Workflow and producing a specification of which group interaction technique is appropriate for solving the problem.

One major requirement of the system is that the Matcher should be designed to provide flexible output specifications, necessary to overcome some practical limitations of the Negotiation system. Namely, the Matcher should not be limited to elect one only technique, since it may be the case that no tool that implements such technique is available in the system. For such reason, the Matcher identifies additional sets of techniques, guaranteeing that alternative techniques may be applied to solve a problem.

Another obvious design constraint is that not all criteria presented in the last section can realistically be implemented in the Matcher. The approach, then, is to select a small set of criteria while allowing space for further incorporation of more criteria in later stages of the project.

With some criteria we have found disagreements in the literature. For example, concerning the number of participants, [14] considers that a usual number for a brainstorming session is 6 to 12, while [24] considers 10 to 20 participants as a typical number. The reasons of this disparity are many: some of the criteria involve subjective appreciations, others are very experimental, others depend on the environment, etc.. Occasionally the reason is that the technique can be implemented in ways not considered at the time they were conceived. A good example is the number of different implementations of the brainstorming technique (e.g. anonymous brainstorming, electronic brainstorming, brainwriting, the Trigger Method, the Sil Method [14, 24]). Taking all of this into account leads to a categorization of criteria in different levels.

The Matcher has been designed to proceed in two levels, divided in five stages, of increasing informality (see figure 5). The first level handles the more formal aspects of the problem, while the second level will be in charge of the informal (loose, inconspicuous) features.

The first level is intended to provide a set of techniques suitable to solve the problem, and covers the first four stages. The system can then either choose directly a technique from that set, or go to the next level composed by the last stage, the fifth one, in which a more precise arrangement is made. This second selection, or subselection, is taken using very fine-grain criteria.

Hence, the second level is not mandatory to the functionality of the Matcher but rather offers a way to refine the matching process in cases where more knowledge about the problem is available in the system or more tools are added to the Tool Bench. Currently, only a small number of criteria is presented in figure 5.

Different organizational information is required at each level of the Matcher. The Matcher will attempt to

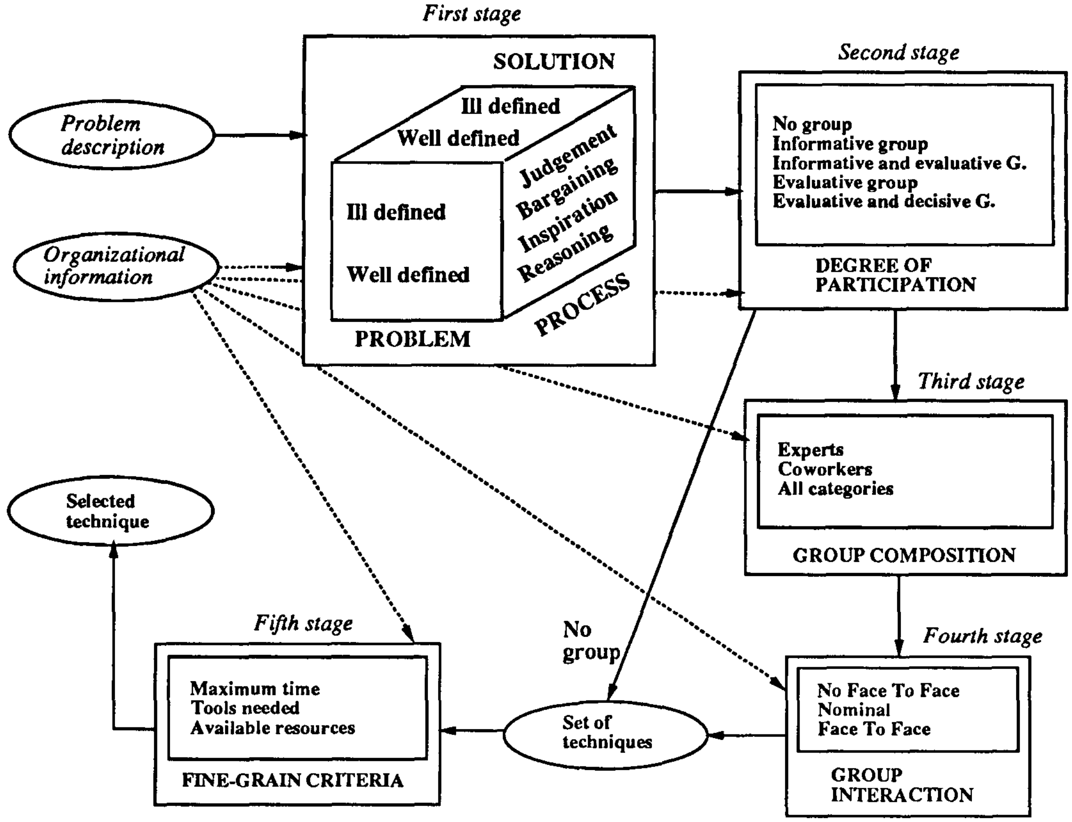

Figure 5: The Matcher.

gather the information from the Workflow system but, when it is not available, human intervention may be requested in the form of a questionnaire.

4.1 The Mapping From Problem to Technique

The mapping from problem to technique is made by the Matcher following the five stages shown in figure 5:

First Stage: the Cube The first stage, the Cube, deals with criteria which were identified as elementary to the specification of the Matcher. The Cube considers different values for three basic aspects of:

- Problem – Ill defined or well defined.
- Solution – Ill defined or well defined.
- Process – Judgment (selection of solutions), bargaining (resolving of disagreement over solutions), inspiration (search for inspired solutions) or reasoning (rational approach).

In the figure, these values are represented in the faces of the cube.

The Cube is constructed by assigning any appropriate techniques to each one of the 16 solution subsets that are discriminated. This procedure follows the guidelines of the models identified in section 3. The figure 7 gives an example of Cube construction.

The output of this stage corresponds to the selected subset of techniques that results from crossing the values for problem, solution and process [4].

Second Stage: Degree of Participation In the second stage the Matcher tries to identify the degree of participation needed to solve the problem through the application of a technique. Its major concern is the formation or not of a group or committee to make the decision. It will also identify the degree of participation of the members of this group in the final decision, since its members may act as simple consultants or as more active participants. The possible degrees of participation

[4]One can argue about how appropriate values for problem, solution and process are assigned. This assignment can be based on several attributes which should be extracted from the Workflow system or otherwise requested to a human agent (e.g. the group manager). [9] identifies attributes of Problem complexity: rarity, precursiveness, openness, seriousness, endurance, radicality. [8] identifies attributes that influence the Solution: politicality of the decision, incompleteness of knowledge, dynamic object of decision, unpredictable environment. [23, 33] present several attributes which influence the Process type: quality, originality, conflict, etc..

are shown in figure 5 and follow the guidelines of the Vroom and Yetton model.

When there is no need for the formation of a group, the Matcher will jump over the third and fourth stages, which are dedicated to group oriented techniques.

Some of the techniques identified in this stage require a manager or facilitator. The output of this second stage will specify the need and qualification of this manager. The Matcher will also suggest a name or role of a person who could act as the manager.

Third Stage: Group Composition At this stage, the Matcher has already identified the need for the formation of a group or committee. It is then the job of the Matcher to decide on the qualification of the group. This decision is based on the Stumpf et al. model. The possible qualifications are shown in figure 5.

The Matcher will also provide names of people who should be part of the group.

Fourth Stage: Group Interaction At the fourth stage, the Matcher will consider the need of a face to face interaction.

The output will be a subset of the group of techniques which fulfill the requirement established in the stage about group interaction. The possible requirements, which are also shown in figure 5, where extracted from the Stumpf et al. model.

Fifth Stage: Fine-Grain Criteria In this last stage the Matcher will assign values to what we have called fine-grained criteria, in opposition to the other more formal criteria considered in the previous stages. Some of these criteria are also shown in figure 5.

The output of this stage will designate a single selected technique, without discarding the previous selections notwithstanding.

The complete output of the Matcher is the following:

1) Problem description (from the Workflow engine).
2) A subset of techniques selected by the Cube.
3) The need or not for a group to solve the problem.
4) If needed, the qualification of the technique manager and, optionally, his/her name.
5) If needed, the qualifications of the group members and, optionally, their names.
6) A subset of techniques complying to the required group interaction.
7) A single technique complying with the above and the fine-grain criteria.

5 THE TOOL MANAGER

The Negotiation system is composed by three modules: the Matcher, the Tool Bench, and the Tool Manager. The description of the functionality of the Tool Manager is of particular interest here, since it mediates the operations of the Workflow with the group negotiation processes. This mediation is illustrated in figure 6.

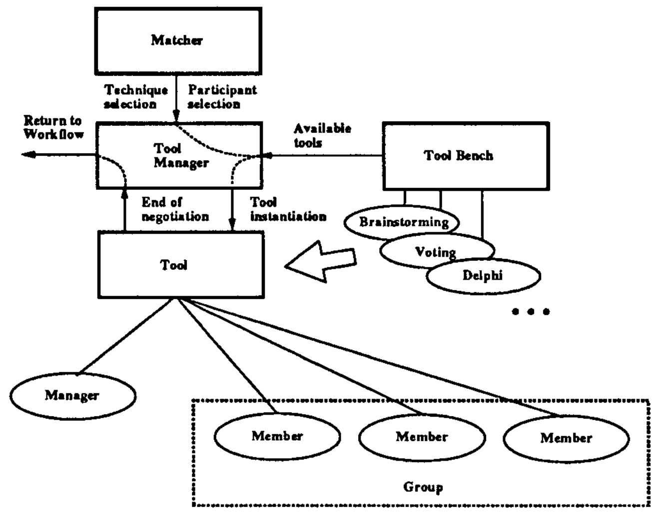

Figure 6: The Tool Manager.

As previously described, the Matcher does not select a tool for executing a particular negotiation process but rather identifies a set of techniques and a set of actors. The Tool Manager is responsible for selecting and launching a tool which will support the selected technique. It is also responsible for returning control to the Workflow system when the group interaction is finished.

The Tool Manager selects tools according to a catalog provided by the Tool Bench. First, the Tool Manager inquires the Tool Bench on the availability of tool support for the single selected technique. If the technique is not implemented, the alternative techniques indicated by the Matcher are inquired in order: group interaction, group composition, degree of participation and, finally, the Cube.

The mapping is scalable in the sense that it is possible to select alternatives depending on the tools available in the Tool Bench while maintaining a degree of consistency with the models for group interaction. As new tools are implemented and incorporated to the Tool Bench, the Tool Manager should be able to select them and the Matcher should be capable to discriminate them. If not, the Matcher has to be upgraded with new criteria in the second level.

6 THE TOOL BENCH

The Tool Bench is the repository of tools implementing group interaction techniques.

Only a small number of the identified techniques has presently been selected for implementation and inclusion in the Tool Bench. At this moment, the goal is to achieve a minimum coverage of the possible selections of the Cube. Six techniques have been selected: Delphi, Nominal Group Technique (NGT), Brainstorming, Dealmaking, Voting [29] and Survey [33]. Figure 7 shows the mapping of these techniques in the Cube such that all possible selections are covered.

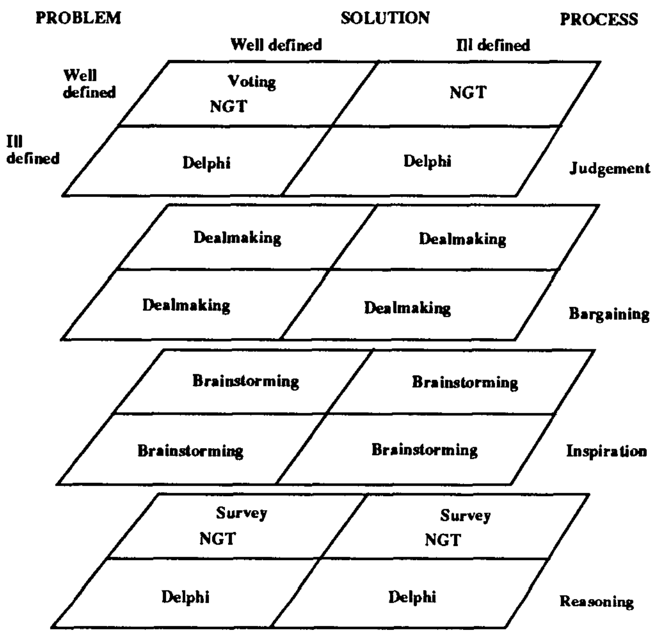

Figure 7: Minimum Mapping of Techniques in the Cube.

Three prototypes of tools supporting the NGT, Voting and Brainstorming techniques have been developed so far [4, 3, 26]. The principles underlying those tools are drawn from multiuser interface architectures and experience has been gained addressing several issues: multiuser interaction modes, concurrency and concurrency control, and awareness of cooperative work.

The tools are currently standalone prototypes that require a process of integration in the framework presented in this paper. This integration has to be addressed in terms of architecture (client server, communications support) and User Interface (consistency with Workflow and other tools, user environment, look & feel).

7 CONCLUSION

The main argument of this paper is that the separation between formal and informal processes causes ineffectiveness of the technological support for organizational activities.

We propose an approach to increase mutual awareness between workflow systems and group interaction techniques. This awareness is based on the notion that informal processes occur when problems emerge at the formal level. The techniques are applied after a process of identification of the problem which matches problem characteristics with the available tools for group interaction.

This work is being carried out in the scope of a larger project called ORCHESTRA. The project addresses several aspects of design and construction of organizational systems, namely diagnosis, automation of procedures, communications, decision and negotiation. The ongoing work in the specific area concerning workflow and group interaction addresses:

- Enhancing the workflow information system with richer organizational information.
- Enhancing the reasoning mechanisms that identify problems and select solution techniques.
- Enhancing group interaction tools towards a better match with both technical infrastructure and organizational environment (groups, individuals, cultures, norms).

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