Support for decision implementation and follow-up

Marcos R.S. Borges [a,*], José A. Pino [b], Carla Valle [c]

[a] *Universidade Federal do Rio de Janeiro, NCE & IM, Caixa Postal 2324, 20001-970 Rio de Janeiro, Brazil*
[b] *Computer Science Department, Universidad de Chile, Casilla 2777, Santiago, Chile*
[c] *Fraunhofer FIT, Schloss Birlinghoven, Sankt Augustin 53754, Germany*

Abstract

Post-decision activities have not had enough research within the decision making cycle. Perhaps they have been considered trivial or not meaningful in the past. However, without an appropriate follow-up, important decisions made in the previous phase may get lost or be implemented wrongly. This paper describes a computer-based support for decision implementation activities. The support includes the corresponding linkage of activities to the meeting decisions that originated them. The proposed system follows a process modeling approach to design the decision implementation activities and uses a workflow management system for process enactment.

Keywords: Decision implementation; Decision follow-up; Workflow; Process modeling

1. Introduction

There has been much emphasis on decision support systems but little attention has been paid to the implementation phase that follows a decision. The gap between the end of a decision making process and its implementation activities may, in fact, turn the decision inconsequent, due to inappropriate support to the decision implementation phase. Often, decisions that are implemented without the necessary follow-up may

generate outcomes which are different from those planned at the time of the decision. As a result, important decisions are not properly or timely implemented (Shim et al., 2002).

This paper addresses the issue of decision implementation support. It discusses why supporting decision implementation activities and linking them to the corresponding decision meeting are essential to make the meeting cycle fully successful. We claim that supporting such link with a computer system is both efficient and effective.

Although the need for relating decision meetings and the activities following them may seem obvious, cultural barriers and lack of appropriate tools induce just informal links. As a result, important decisions are not properly or timely implemented. It appears, then, that all efforts to

---
[*] Corresponding author.
E-mail addresses: mborges@nce.ufrj.br (M.R.S. Borges), jpino@dcc.uchile.cl (J.A. Pino), carla.valle@fit.fraunhofer.de (C. Valle).

make good decisions with information systems and/or operations research models and techniques are threatened by deficient implementation. Follow-up meetings are sometimes scheduled to cope with the absence of implementation reports readily available. In turn, these meetings are likely to suffer from lack of information and context.

We identify three aspects of post-decision support: the decision implementation plan; the follow-up of implementation activities; and the awareness support to external members. Each of these three aspects is provided by the functionality of the system we propose.

The approach we chose for the proposed solution is the use of a library of process patterns common to several decision implementations. The process patterns are adapted to the specifics of each decision and converted into an implementation plan. The plan is then the input to the workflow engine and the process instance is enacted. Monitoring and interaction tools are also part of the environment.

The paper is composed of seven sections. Section 2 discusses the decision meeting life cycle and the motivation for the proposed solution. Section 3 describes the requirements for the link between the decision meeting and its corresponding implementation. Next we present the architecture and functionality of the proposed solution and how the solution can be implemented. Section 5 presents a case study and Section 6 has a general discussion on the suitability of the approach. Section 7 concludes the paper.

2. Decision making life cycle

A decision making process can be defined as consisting of a set of four major steps: the problem definition; the identification of solutions; the selection of the best option; and the decision implementation plan (Simon, 1977). This straightforward classification puts emphasis on the idea that the decision process only ends after the activities resulting from the decision are actually implemented.

Balasubramanian et al. (1999) define decision making as a process of selecting the options that are most likely to lead to the desired outcomes from a set of tentative solutions. Their process entails various steps and stages that decision makers engage in, either explicitly or implicitly. Among the defined steps, Balasubramanian et al. list the decision enactment and the reviewing of its results.

These examples illustrate few cases where researchers consider the decision enactment an essential part of the decision process. However, due to the complexity of the first three steps of the decision making process, most research focuses on supporting these activities and little attention is given to what happens after defining the problem solution, i.e. the decision implementation activities. The gap between the moment a decision is made and its corresponding implementation may, in fact, turn several decisions inconsequent, due to lack of appropriate support to the implementation follow-up.

2.1. An example

In order to illustrate the situations of this section and the requirements defined in Section 4, we describe a simple scenario, common to many organizations. In this simple and hypothetical scenario it is possible to recognize a number of elements frequently found in decision meetings and its subsequent steps.

The Executive Board of a company meets regularly to decide about requests or proposals originated from the company's divisions as well as to define policies and goals to be followed by the entire company or by one or more divisions. On the one hand, when a proposal is originated in a division, it usually comes with an implementation plan. The decision whether to approve the proposal or reject the request is based on both the proposal and the implementation plan.

On the other hand, when the proposal originates in the Board, the decision is made with a purpose in mind. It is up to the division(s) in charge of the implementation to study the defined goals and to elaborate a plan. Although both situations result in actions to be performed, their development is quite different.

When the proposal originates in a division, the implementation group has already discussed an

implementation strategy, which becomes part of the proposal. A proposal example may be a marketing campaign. The Board has an idea of the task and who will be responsible for each activity in the plan. It is primarily a matter of follow-up. Unfortunately, this is not always the case. Changes in the plan or in its goals may be required in the course of task accomplishment. In some cases the changes may actually alter the essence of the decision or the basis on which it was approved.

The second situation is even more complicated, as the Board passes on to the implementation team a set of goals, not necessarily detailed or thought for implementation. Consider an example when the Board decides a five per cent cut in the energy consumption at the company. A team is assigned to define and implement a plan to achieve this goal.

2.2. The support for post-decision

There are many decision support tools. They include software to make analytical computations, brainstorming support tools, idea organization programs, various systems to gather preferences, priorities and votes, electronic discussion tools, and comprehensive systems including many or all of the above functionalities (Nunamaker et al., 1993, 1995; Borges et al., 1999). Few, however, address the explicit support for the implementation phase.

Post-decision or decision follow-up can consider all activities that happen between the act of making a decision and its full implementation or the explicit definition of its end for any reason, such as lack of resources or change of context. The activities embedded in this phase can vary from the elaboration of a complex plan to simple activities such as to write a document, or disseminate some information.

Most of the computing support for the post-decision is done with general tools, such as a project management system for complex jobs and electronic mail for simple tasks (Levitt and Mahowald, 2002). This may be satisfactory from the viewpoint of implementation teams, but it does not provide an appropriate support for the interaction that should exist between decision and implementation teams. This support is aimed at having communication between these two teams in view of necessary

adjustments to the implementation plan. It should include activities such as implementation follow-up, support for solving conflicts generated by adaptations in the implementation plan affecting the decision, provision of awareness to those people affected by the plan or interested in it and generation of organizational memory that could help future decisions (Abecker et al., 2000).

People participating in the first three phases of a decision making process will probably be the same (except perhaps for a few advisors or observers who may participate just in one of the phases). On the other hand, people working in the post-decision phase are implementers, most probably different from the decision makers participating in the previous phases. This increases the chance of misunderstanding or misinterpretation, justifying the need for a formal and well-established communication channel between the two groups (Kraemer and King, 1988).

If, for example, a manager wants to know which is the current status of the energy cut decision, he will probably have to search in several sources or to ask several people to get the desired information. In many cases, the time or the accesses to the sources are constraints for this activity. A similar situation occurs when the implementation team wants to clarify some aspects of the decision. Either he has to interact with all members of the Executive Board or he must make assumptions without consulting the Board.

2.3. Benefits to the organizational memory

According to Russo and Schoemaker (1989), it is not enough to simply make a decision and move on. We must periodically review our decisions and consider that if we fail to track the results of our decisions, and fail to analyze them to reveal key lessons, we are wasting good opportunities for improvement.

For Svenson (1992), the follow-up of the decision implementation is fundamental to the evaluation of the quality of past decisions and as background knowledge for present and future decisions. Svenson and Benthorn (1992) justify their beliefs by stating that decisions should be made to withstand the roughness of the future. In

particular, post-decision external events and outcomes could imply that another decision would have been better.

Therefore, the decision follow-up can be seen to serve a similar purpose in bringing the appraisal of an earlier decision more in line with the perception of the decision as reflecting their current attitudes (Conway and Ross, 1984 cited by Svenson and Benthorn, 1992).

Some authors consider that capturing and organizing the information and knowledge involved during the decision implementation, and make them available to decision makers can also contribute to avoid past mistakes and to help to find out best organizational practices (Tiwana and Ramesh, 2001; O'Leary, 1998). We selected the following assertions from their works:

- Many mistakes are frequent in organizations and some of them are related to the lack of information and knowledge about previous experiences.
- Other mistakes are frequent because of the lack of planning and control of decision implementation.
- Knowledge and information are generated during a decision implementation.

3. Post-meeting support requirements

If we assume the actual meeting is part of a cycle of activities aimed to discuss, decide, plan, execute and evaluate organizational policies and procedures, which are the requirements for the post-meeting stage of this cycle? The post-meeting stage and the transition between meeting and post-meeting are presented in this section. We describe three requirements we believe are the most relevant to support the post-meeting phase. For each requirement we discuss the problem motivating it, the proposed solution, the foreseen benefits and the required functionality.

3.1. Implementation plan

After a decision is reached, the implementation plan is usually left to the team in charge of imple-

menting it. In spite of the details discussed during the decision process, it is uncommon that a specific implementation plan comes out from a decision meeting. Decision evaluation criteria are seldom generated either. As a result, relevant information is produced outside the meeting and in most cases is not made available to meeting participants. The information exists but there is no mechanism to make a connection between these two stages.

The problem is aggravated when the implementers of a decision are not members of the group who made the decision. Links are either informal or done only at the end of the implementation stage. Unfortunately, eventual problems cannot be solved at that time. We propose explicit and formal links between the decision made during the meeting and its corresponding implementation plan. This is achieved by enforcing activities to promote awareness and interaction between these groups in the implementation plan. This occurs on two occasions in the implementation decision planning described in Fig. 1: when analyzing the plan and when a problem is detected while both groups are discussing. The decision planning process shown in Fig. 1 was generated by the Provision Workbench™ tool (Proforma Corporation, 2003).

The implementation plan, the resource allocation and its corresponding enactment should all be considered as part of the decision process. The information generated as a result of a decision should not only be made available but also kept up-to-date in conformity with the actual execution plan. Besides, there should be a link between an operation under execution and its corresponding evaluation criterion.

If the execution plan is formally required, potential problems can be promptly detected, increasing the efficiency of the process. The execution plan will permit the decision team to closely follow the implementation operations, identifying and correcting any undesirable changes or shortcuts. Besides, if the evaluation is linked to the execution plan, it facilitates the future assessment.

Post-meeting support should provide means to rapidly draft an execution plan and publish it. In addition, it should allow changes to the plan even while it is being accomplished. The system should provide means to generate tasks to the
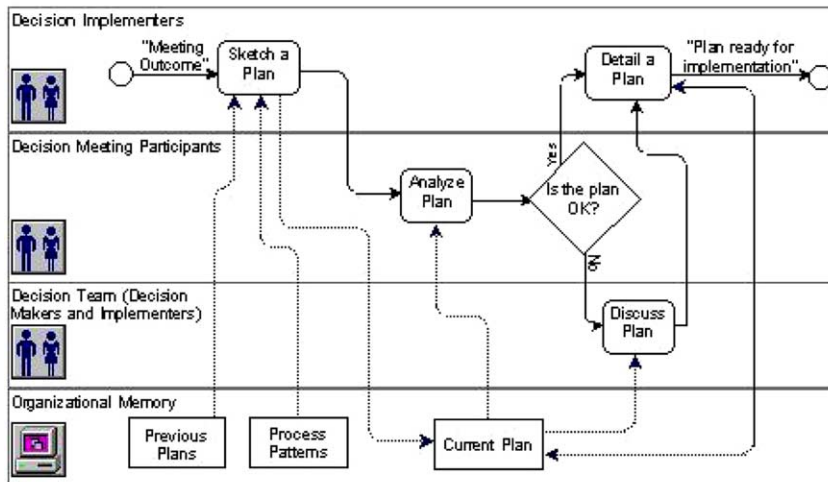
Fig. 1. Design process of post-meeting implementation plan.

implementation team, based on the proposed execution plan. Finally, the system should record the completed tasks and their reports.

3.2. Follow-up activities

Once a decision is made and a task force is assigned to implement it, it is frequent they become disassociated. In addition to obvious time delays, the implementation task becomes an activity supervised only by the organizational structure to which the task group belongs. This situation is undesirable due both to the risk of losing the essence of the decision – as mentioned before – and to the difficulties of evaluating the decision results within the meeting life cycle.

If the meeting life cycle discussed in Section 2 is adopted, then all decisions should only be completed within the cycle, allowing the preservation of links among its three stages. This means a decision is either open or concluded. This procedure does not prevent independent operations to emanate from decisions, but for the sake of consistency all derived operations should be recorded within the cycle.

The benefits of this approach are twofold. First, it allows meeting participants to keep track of unresolved decisions. Thus, decisions cannot simply "die" or have an independent existence without an explicit determination. Second, it forces the results of one stage to proceed to the one responsible for its evaluation and conclusion, generating a desirable feedback. The solution requires a well-defined process based on the meeting life cycle and the support of a database to store the decision steps and results. This approach allows the system to provide retrieval of past decisions, in case a user wants to study the history of events related to a certain decision. Decisions, their development sequence and the names of the involved people should all be recorded. In that way, a collaborative scenario could be created, allowing direct exchange between a user who wants to learn a specific situation and another person who has an experience on it.

Therefore, it is necessary to establish a *formal* link between each meeting outcome and the result of its implementation. Moreover, if the implementation procedure is detailed into working steps, it should be possible to control its execution and to correct eventual misunderstandings.

There are several benefits of this formal link between each meeting outcome and its corresponding implementation procedures. First, it

would allow a formal definition of responsibilities and expected results. Second, if an automated system is provided, it can allow a better control of the outcome implementation. Finally, it may make the meeting cycle efficient by reducing time spent during the meetings for follow-up activities.

A system supporting the post-meeting should be prepared to receive the meeting outcomes in the form of well-defined processes where working steps, their corresponding flow, outcomes and responsibilities are initially determined. Then, it should be able to register or even better, to control the execution of these steps, allowing people directly involved in the execution to track its progress. People with some interest in the process but not directly executing the steps could also have access to the tracking information.

3.3. Interaction and awareness

When people make a decision, they often do it under some time pressure. In most cases there is no time to go into implementation details. It is left to the implementation group to solve eventual problems and ambiguities. However, the chosen implementation options might sometimes change the essence of the decision. Thus, some interaction between decision making and implementation groups is desired. If this possibility is not readily available, then either the implementation work is postponed until another meeting is scheduled, or the implementation group chooses the option to be followed.

Both situations described above should be avoided. Ideally, a direct communication channel between the involved parts should be formally created, encompassing each outcome implementation. This channel should work as an extension of the meeting that originated the decision, allowing the task to be adapted in conformity with the decision. Complex decisions benefit most from this approach.

One may argue that e-mail and/or telephone could solve this problem, but hierarchical barriers, informality and absence of context may impose restrictions to communication. The proposed communication channel is particularly important when meeting participants are geographically distributed and cannot be easily reached by the

implementation group. The channel has also the benefits of allowing users to track the discussion generated during the implementation and avoiding informal interactions that are difficult to retrieve afterwards.

The main requirement is to create a communication channel for the involved people within the context of each outcome. The interaction through this channel should be structured and persistent. The nature of this type of communication is typically asynchronous, but real time interaction should also be provided for rapid problem solving. Ideally these interactions should also be documented and thus they would become available for eventual future retrieval.

Another aspect of the communication channel concerns the definition of the persons allowed to know about the decisions and their implementation. In our experience, a certain decision can affect many people besides those directly involved in its conception and implementation. It may be of peripheral interest, e.g., to high-level management, but be of much interest to people affected by it. It is a fact that many meetings do not provide appropriate information to outsiders. This is also true during the implementation period. The lack of awareness information generates informal demands, which are time consuming to knowledgeable people. Additionally, these requests are not appropriately answered in most cases. Simply preventing people from accessing the information is not a solution: people will use their informal channels creating extra burden to the decision making or implementation groups.

The straightforward solution to this problem is to provide some awareness information to outsiders. Considering that not all details are relevant and open to outsiders, an awareness mechanism should somehow filter the information (David and Borges, 2001). The organization can avoid misunderstandings and anxiety by organizing information dissemination about meeting decisions. It can also add efficiency to the implementation process by allowing the task force to concentrate on its job instead of spending time in supplying information to outsiders.

A system supporting follow-up information should also take care of outsiders' requests. In

other words, people should be able to track the execution steps as well as to have a view of the general plan. The system may also automatically inform persons about previously selected items of their interest.

4. Designing post-decision support

From our viewpoint, post-decision activities should be explicitly defined and assessed by both decision makers and implementers. The requirements described in the previous section suggest a workflow-like solution where working plans can be described and enacted. The proposed solution is a system combining a process design tool with a workflow enactment tool. However, given the ad-hoc nature of the processes, it will be difficult to use a commercial Workflow Management System (WfMS) alone. Even with the adoption of a WfMS for process enactment, additional monitoring tools will be necessary. We describe now how the requirements from Section 3 can be implemented.

4.1. Implementation plan

We need a process design tool in order to generate a decision implementation plan. Most WfMS provide such tools, but their approach is directed towards production processes, where you plan once and enact many instances. Another typical WfMS limitation is that although one can use previous models to generate a new one, the WfMS provides little support for reuse. Besides these limitations, the WfMC – a consortium of companies aimed at defining common workflow architecture – suggests the separation of the process definition from the process enactment in two different modules (Wfmc, 2003).

A process plan associated with each decision is our preferred approach. Unlike traditional business processes, we assume that each plan will have only one instance. Therefore, we can make changes to the plan as needed during the process execution. By contrast, these changes cannot be easily made to usual business processes, where the same plan is the base of several execution instances.

Suppose in our Section 2 example that the Marketing Division proposes a new advertising campaign. Besides detailing and arguing in favor of the benefits of their proposal, the Marketing Division also includes an implementation plan, as depicted in Fig. 2(a). The Board decides to approve the merit of the proposal, but puts some restrictions on the budget. It asks the advertisement designs to be done in-house, to save the cost of hiring a design agency. The Board then adjusts the implementation plan substituting the "Hire Designers" activity by the "Perform Design" activity and assigns it to the Design Division, as shown in Fig. 2(b).

The proposal returns to the Marketing Division and it is labeled "Approved with changes". After assessing the changes, the Marketing Division contacts the Design Division again – this had been done at the time of the proposal, but the design team said they could not do it within the proposed time frame – communicating the Board decision and asking them to include the campaign design in their schedule. They reply informing that the design team cannot do it, unless they delay the work they are doing for another campaign. At this point, both plans return to the Executive Board. After considering the implications, the Board decides to review its previous decision on the budget and to approve the original plan.

The implementation plan designed in a process-like fashion facilitates both the understanding of the implications and the definition of alternatives. To model the process we only need a process design tool, such as the Provision Workbench™, used in these examples (Proforma Corporation, 2003). In this case, the tool allows us to visualize the process, but not to execute it. On the other hand, if we adopt a workflow system such as Lotus Workflow (2002), we can do both, i.e., visualize the model and enact it. Process enactment is what allows us to fulfill the next two requirements. This was one of the reasons to choose Lotus Workflow in our implementation.

The process modeling tool should have a simple user interface independently of the enactment capability. Unfortunately, process design is usually time consuming and complex while using most commercial workflow tools. Even simple processes

Workflow Modeler:Launch Advertising Campaign

(a)

Workflow Modeler:Launch Advertising Campaign 2
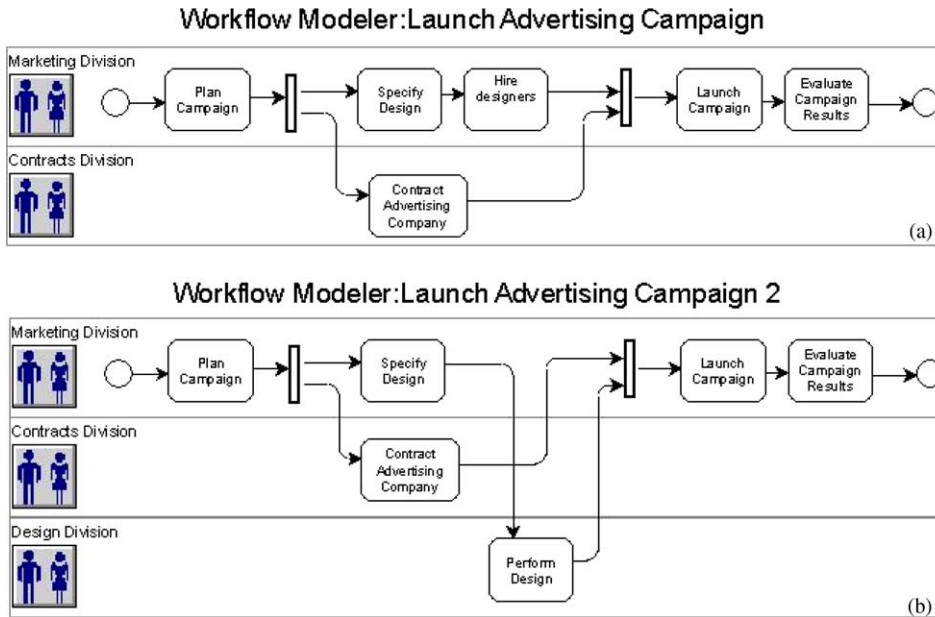

(b)

Fig. 2. (a) Implementation plan as initially proposed. (b) Implementation plan as approved by the Board.

require a specialist skilled both in process modeling and in the use of the software. Therefore, it is desirable to provide some additional facilities for the process definition, reducing time and effort required to generate the models. We suggest the adoption of a process pattern approach to overcome these obstacles. In this approach, a number of process patterns are made available to the designer based on the characteristics of the domain.

Specifically, we chose the use of process patterns on the decision implementation domain. The process patterns would work as a guide to implementers when dealing with decision implementation plans. A pattern is defined as a generalized description of a set of recurring rules that can be associated with a workflow schema (van der Aalst et al., 2003). Following this approach, designers can reuse previous experiences to improve the speed and quality of the schema design process (Casati et al., 2000).

An example of a process pattern is shown in Fig. 3. The workflow model was designed using the Lotus Workflow tool. The process pattern in this case tries to represent the activities required to call

a meeting, a common outcome of many decisions. Besides illustrating the process model, the pattern description contains other elements to guide its selection.

By providing a library of commonly used patterns, we can facilitate the process model. The process designer has only to select the patterns she needs and use it directly or combine them to form a process. We start with a library of typical decision implementation plans that can be executed as it is or used to generate a new plan. Plans can also be transferred to the library after a successful adjustment during enactment. An initial list of process patterns in the decision meeting domain is reproduced in Table 1. The list is, of course, incomplete, but it may serve to illustrate our approach.

The interface with the modeling tool is shown in Fig. 4. The left frame shows the process design area, while the right frame shows the list of patterns stored in the library. As we mentioned, one may combine several patterns to describe a process or use an existent pattern as the basis to generate a new one, as presented in Fig. 4. We illustrate the design of a new process (incomplete) that uses
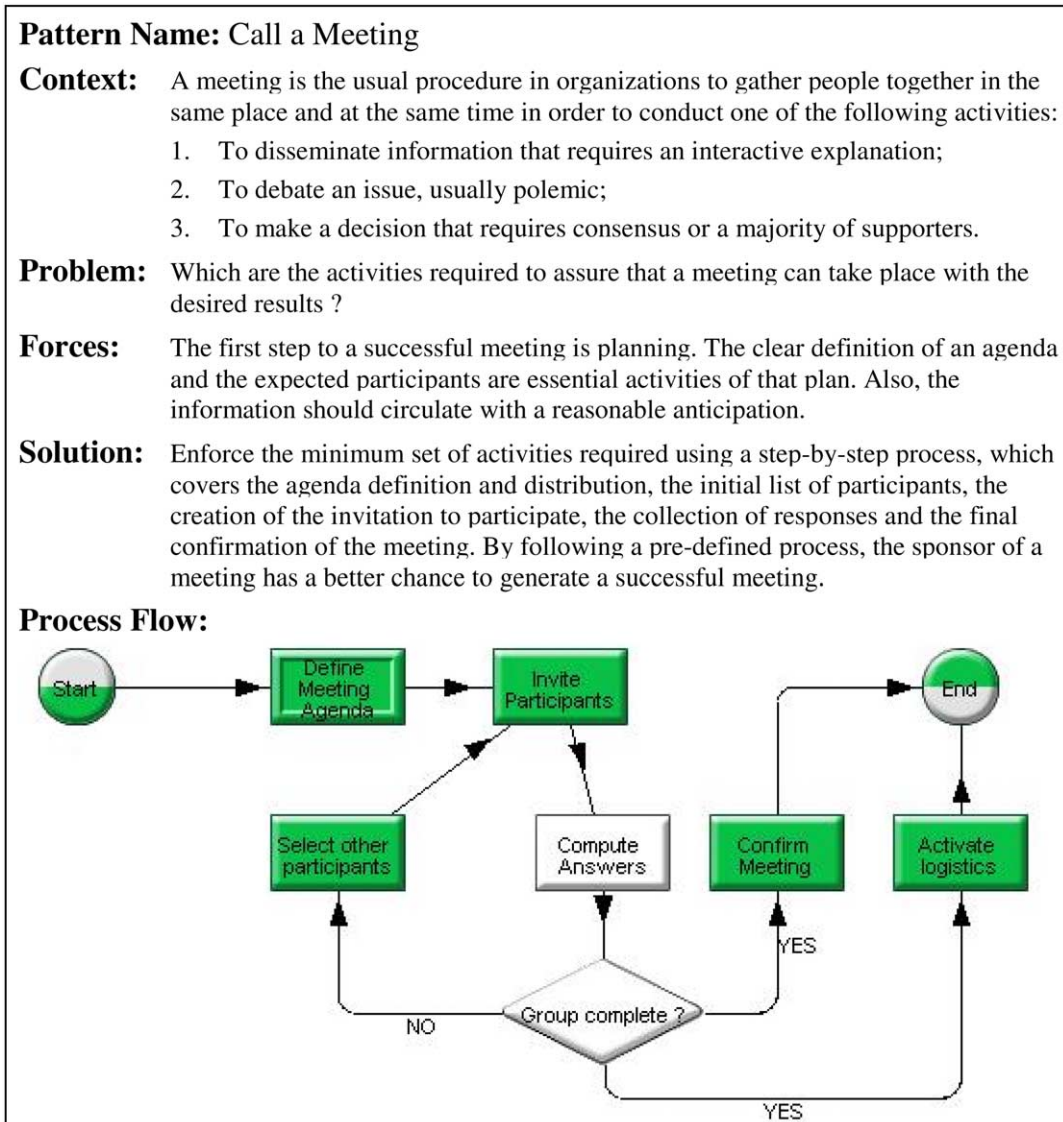
Pattern Name: Call a Meeting

Context: A meeting is the usual procedure in organizations to gather people together in the same place and at the same time in order to conduct one of the following activities:

1. To disseminate information that requires an interactive explanation;
2. To debate an issue, usually polemic;
3. To make a decision that requires consensus or a majority of supporters.

Problem: Which are the activities required to assure that a meeting can take place with the desired results ?

Forces: The first step to a successful meeting is planning. The clear definition of an agenda and the expected participants are essential activities of that plan. Also, the information should circulate with a reasonable anticipation.

Solution: Enforce the minimum set of activities required using a step-by-step process, which covers the agenda definition and distribution, the initial list of participants, the creation of the invitation to participate, the collection of responses and the final confirmation of the meeting. By following a pre-defined process, the sponsor of a meeting has a better chance to generate a successful meeting.

Process Flow:

Fig. 3. An example of a process pattern for calling a meeting.

three patterns of the library. The "Perform a Task" pattern was renamed to "Collect Budget Info" and stored as a separate process after being adapted (as the lower window is showing).

4.2. Follow-up activities and awareness

Follow-up is provided in our approach by two types of procedures. First, we have the process model that resulted from the initial agreement between the decision maker and the implementers groups. As already mentioned, the process model describes the precedence of activities as well as who is responsible for each activity described in the plan. The plan in this case provides the common understanding upon which the problems that may appear can be solved by means of interaction among members of the two groups.

Table 1
Process patterns for the organizational meeting domain

Process pattern	Activities	Expected output
Call a meeting	Define date, time, duration and place Define list of participants Confirm participation Distribute agenda	List of participants (confirmed) Meeting details
Investigate information	Find information source Find related information	Report investigation
Verify information	Find information source Check veracity	Report findings
Plan task execution	Define task inputs and outputs Describe task activities and deadlines Define person(s) in charge	Task execution plan
Perform task	Plan task Define work force Confirm deadline feasibility Perform task	Report execution Distribute outputs
Disseminate information	Define target list Define information contents Distribute information	Report dissemination
Disseminate information and receive feedback	Define target list Define information contents Define contribution deadline Distribute information Compile contributions	Report dissemination Report contributions compilation
Prepare a report	Define report scope and deadlines Define person(s) in charge Produce report	Deliver report
Prepare meeting minutes	Transcribe minutes Distribute initial version Receive contributions Correct minutes	Meeting minutes

In order to support this interaction, each implementation plan is associated with a discussion forum where the members are those who participated in the decision and those belonging to the implementation group. The forum enables the discussion of details about the plan and, most important, it helps to resolve situations without the need of additional decision makers' formal meetings. The advantage of associating the plan with the forum is that it provides a consistent context where the discussion can occur smoothly. Furthermore, the forum also serves as a document for later reference and reuse.

Lotus Workflow – the application development tool we have chosen – enables users to develop, manage, and monitor their business processes (Lotus Workflow, 2002). Since it provides reusable object libraries, the tool is very suitable for the implementation of process patterns with little effort.

Moreover, use of Lotus Workflow eases the interaction because it already provides a discussion forum through the Lotus Notes environment. The forum can be adapted to support an argumentation model such as IBIS (Kunz and Rittel, 1970), but even the plain discussion model provided by
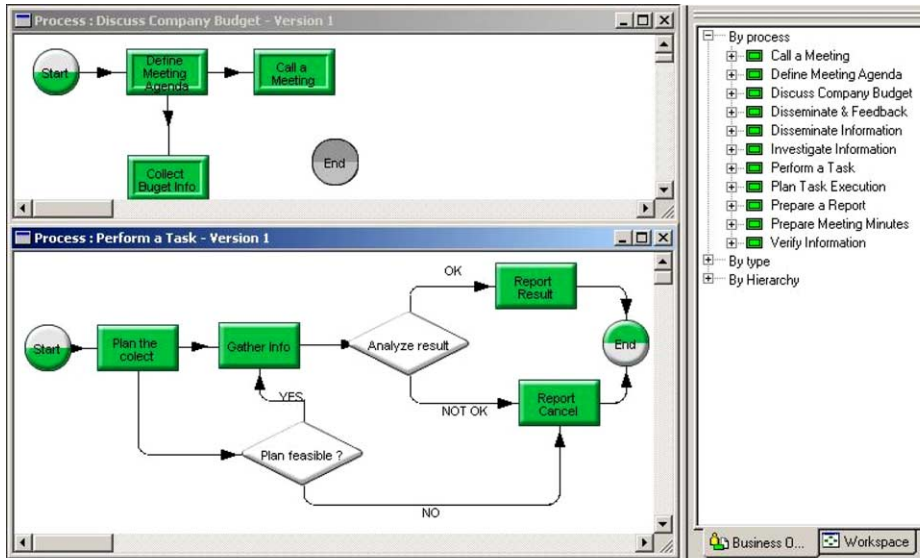
Fig. 4. The Lotus Workflow Desktop with process patterns.

default can be useful. A facilitator coordinates the forum, but most interaction in our experiments was allowed to run freely. It is important, however, that the discussion should be focused on the implementation plan. Important issues, which arise from the interaction but are not related to the decision and/or implementation theme, should be directed to another forum. This can be easily done in the Lotus Notes environment.

Plans can have versions to facilitate documentation of the discussion. When a new plan is created as a result of an agreement generated by the discussion, the plan is stored as a version of the previous plan. This helps to keep the discussion within the context.

The second mode of follow-up is made available by the use of a WfMS supporting process enactment. While a process is a blueprint for a particular kind of work to be accomplished, a job is the actual work that is done according to its process definition. Jobs are initiated and carried out by people in an organization or by other applications, programs, or automated activities to accomplish specific goals according to the various processes that have been designed for the organization. A job owner may monitor the job, receive electronic mail notices of its progress, and intervene if it is not proceeding according to the plan.

The WfMS provides many resources to our follow-up scheme. It places the person in charge of the implementation with full control over the execution of activities. It also allows ''outsiders'', i.e., people not directly involved in the execution of activities, to monitor the process. As the Lotus Workflow interface can be made through the Web, it also allows the process to be remotely monitored.

Lotus Workflow reproduces the design of the process and marks the activities that have already been executed or skipped with a different color (in case the execution follows a different route). Management and people affected by the decision can also benefit from this explicit awareness. Awareness can also be provided by a notification mechanism (such as an electronic mail message sent when a process reaches a subscribed activity) or through an application allowing access to the workflow database.

The full awareness of the process plan and its enactment provide means to correct the decision implementation or perform adjustments. While the decision implementation plan provides a full view

of the process activities, the process enactment through a workflow system provides the follow-up of its realization.

An important issue appears when plans undergo changes while they are already under execution. If the change occurs on steps of the process which are not yet executed, it is only a matter of moving the data from the old plan to the new plan. On the other hand, if the plan changes on already executed parts of the process, some interaction is necessary to decide what to do now. Again, the forum can play an important role in supporting this interaction.

Suppose, e.g., that after following the implementation plan of Fig. 2(b), the process reaches the "Launch Campaign" activity. At this point, the design job carried out by the Design Division is not approved. After some interaction, the Board decides to return to the original plan, illustrated in Fig. 2(a). Ideally, all results from "Plan Campaign", "Specify Design" and "Contract Advertising Company" should be kept and used in the alternative plan. However, it might not be the case if implementers argue for a new design specification to solve the recent problems.

Again, the actual implementation development can be stored for future reference. The WfMS automatically logs routes, performers and times. Task performers can record troubles and good experiences found when carrying out the tasks. All this information can be used when designing future plans.

5. A case study

An example is provided by the decisions made at a University Department (UD). This Department has a Chairman, about 20 full-time professors and about 15 support personnel, including an Administrative Manager, an accountant, secretaries, computer technicians, and others. Besides, there are part-time instructors, teaching assistants and undergraduate and graduate students. The Department is responsible for doing research and teaching in a particular field of knowledge within an Engineering Faculty. The Department had a recent growth in activity and thus, many of the

previous ways of working have become inadequate.

Important decisions at UD are taken by a Council, composed of the Chairman and four elected full-time professors. The Council did not have a fixed schedule of meetings, but that proved to be a bad idea. Regular meetings are now scheduled every week. An agenda for each meeting is agreed by e-mail two days in advance. One of the Council members serves as Secretary. He takes notes of the decisions made in the meeting and shortly afterwards sends a proposal for the minutes to the other Council members by e-mail. After the necessary corrections, the minutes are approved and distributed to the other full-time professors and to the Administrative Manager.

Implementation of decisions was left to the responsible persons who had to infer their tasks from the minutes. This simple-minded design caused many problems. One of the problems occurred because some decisions involved more than one person, e.g., a decision concerning undergraduate teaching and administrative resources (who takes the lead in implementing such decision? the Administrative Manager? the professor chairing undergraduate teaching?); how about task deadlines and the global deadline?

A simple post-meeting support was then decided. A set of tools was made available to the Council Secretary. These basic tools consisted of a shared calendar system and a library of forms for e-mail communication. As it will be discussed below, these tools fall short on the need of post-meeting support, but they were provided as an initial, simple approach.

The calendar system used was Apple iCal (Apple Computer, 2003). It was easily available and provided multiple access from all authorized UD people. The Council Secretary used this tool to place all scheduled deadlines there. The Chairman's secretary was instructed to check this global calendar every day and remind people of their promises if they were not delivered on time. Whenever someone finished a scheduled task, put an achievement symbol next to the corresponding entry in the calendar.

The forms library was a basic implementation of the patterns library. The included forms

supported the basic implementation and follow-up tasks for typical Council decisions. They were designed for the Council Secretary's use. After filling a form, the Council Secretary sent an e-mail message with it to the involved people. If one of the recipients was the Administrative Manager, she forwarded the message to the support personnel also involved in the implementation of this decision (the Council Secretary did not detail tasks for the administrative personnel).

University Department

Form type: 11
(Sequential multitask decision)

Date: Dec. 12, 2002

Decision Implementation title: Replace computer equipment at Lorentz Laboratory
(quote this title on all subsequent communication)

Council Meeting date: Dec. 10, 2002

Due date: Jan. 31, 2003

Responsible persons: M. Smith, J. Jones, C. Bond
Decision (quote from Council minutes): Considering the request from the Undergraduate Teaching Chairman, the Council decides to authorize the replacement of old computer hardware and software with new one for the Undergraduate Lorentz Laboratory. The number of workstations will be the same. Maximum authorized budget: $28,500.

TASK No. 1
Specification: Determine minimum and desirable hardware and software requirements for the Laboratory workstations.
Responsible person: J. Jones
Due date: Dec. 17, 2002

TASK No. 2
Specification: Get quotes from three vendors for the specified items.
Responsible person: M. Smith
Due date: Dec. 27, 2002

TASK No.3
Specification: Decide items to be purchased withing budgetary limits and to which vendors.
Responsible person: J. Jones
Due date: Dec. 31, 2002

TASK No. 4
Specification: Purchase the items and get them delivered before the due date.
Responsible person: M. Smith
Due date: Jan. 13, 2003

Fig. 5. First page of a filled form as sent by the Council Secretary (translated into English; actual names have been changed).

Fig. 5 shows the first page of a filled form as sent by the Council Secretary. Note that the Secretary in many cases has to check with the implementation personnel about the feasibility of the deadlines.

The results of this implementation are presented now. Several benefits were obtained:

- Responsible persons and deadlines are clearly determined with this approach. The delays in implementing decisions were significantly reduced.
- Many disagreements are also detected early in the implementation. A typical case occurs when an implementer disagrees with the feasibility of the task or the specified deadline to do it. In these cases, the issue is treated in the next Council meeting.
- Several implementers like the fact of having their work documented.
- The Council Secretary likes the Forms Library, instead of ad-hoc messages. A few of the current forms have been created by the Council Secretary himself.

There are some problems with the implementation as well:

- Messages are sometimes lost or erroneously handled and there is no repository of pending tasks for each person.
- Tracking the status of each decision implementation is rather difficult to do. In particular, the Chairman has complained about this.
- Some tasks are of a confidential nature. Since the calendar is open to many people, the Council Secretary has opted for disguising the title of some decisions in the calendar. This is not a good solution, since some people then ask for a clarification of those decisions.
- The Council Secretary has complained about additional work to fill the forms and forward them to the responsible persons and to put entries in the calendar.
- Some people sometimes forget to do a required step: put the "completed" symbol in the calendar or send the results of a task to the person who needs them afterwards.

Considering these results, the Department values the benefits, but the general feeling is that the remaining problems should be solved. Thus, the UD is considering to support the decisions implementation with the approach proposed in Section 4. A discussion on the lessons learned is provided in the next section.

6. Discussion

The basic proposal of this paper is that decisions need careful follow-up and they should be computer-supported. However, this is not obvious. On a first look, decision makers may think implementation is straightforward and implementers "just have to carry out the decisions". Implementers, in turn, may disregard the need for supervision and follow-up: if they are in charge, why do not you trust they will do implementation well and on time? Moreover, our experience with decision makers and implementers is that when they are initially confronted with past cases of decision implementation delays, they dismiss those cases as being too particular.

It seems, then, that some strategy to convince involved people in the Organization is needed (Courtney, 2001). One such strategy may be to document decisions and their implementation over some period of time. If, as expected, many decisions are implemented late or are forgotten, this documentation may be a good argument to ask for decision implementation support and follow-up.

An alternative strategy may be to do implementation support in stages. A first stage may include the use of simple off-the-shelf tools. They may be Project Management Systems (PMS), electronic mail, telephone, to-do lists and others. Of course, these tools fall short of providing the needed support. For instance, a PMS provides timetables, alarms when time scheduled for a task is exceeded, Gantt charts, etc., but it deals with projects, not decisions. However, people experience the advantages of getting support and ask for a second stage with better tools. Our case reported in the previous section shows this sequence, despite the fact it was not planned in this way.

One of the advantages of the proposed approach is to have available a wealth of information generated during a decision implementation. In our experiment, the information was not used only in the context of each implementation, but for other purposes as well. Implementers liked to have their work documented (although there was not an explicit link to job evaluation, it is clear they thought this was objective material which could be used for that purpose). Many people liked to be able to review past decisions and find specific data they could not remember otherwise. This information can be considered part of the Organizational Memory and thus, it can be appropriately managed with an Organizational Memory System.

Another advantage of supporting post-decisions is the accrued patterns library. Over time, the process definitions created under the library can become a storehouse of "best practices" for the organization. In our limited experiment, the forms library evolved to include all typical decision implementation sequences in UD, which involved some discussion – never done before – on how certain decisions should be implemented.

From the social and organizational perspective, this technological approach can provide opportunities for collaboration and exchanges that traditional tools support in a very limited way (Barthélemy et al., 2000). An example of this is asynchronous interaction: although electronic mail allows it, an *in context* discussion enabled by the tool provides focused interaction and controlled information persistence.

The implementation of a workflow to support the post-meeting stage should be done in agreement with the operational environment of the users. This means the same operating system and network they are currently using. Moreover, it is desirable the workflow be a part of or function tightly coupled with the software systems people are using. In particular, if people are using computer-based tools to support pre-meetings and/or meetings, it seems reasonable the post-meeting tool should have a direct relationship with them, easing its adoption and use.

7. Conclusions

In Section 2 we mentioned Simon's four steps for the decision making process: problem definition, identification of solutions, selection of the best option, and decision implementation plan. We have argued for supporting the last step, which is frequently disregarded as being considered trivial. Of course, this does not mean the other steps should not be supported by technology. On the contrary, perhaps the best results can be obtained with a comprehensive support for all steps.

Assuming the fourth step is to be supported, we may try to evaluate the effectiveness of the proposed approach. Is it worth to make visible the activities concerned with the post-meeting? When comparing with traditional meetings we may notice there are several gains. First, there is a structured follow-up of the decisions made at the meeting. Secondly, there is explicit awareness of task progress for all involved roles. Third, there is Organizational Memory capture of potentially valuable information. Fourth, there is easier identification of several items after the meeting: issues for the next meeting life cycle, unclear details of the decisions just made, and unsettled issues after some tasks have been done. Fifth, there is a potential for accruing "best practices" of the Organization. Finally, there are opportunities for collaboration and improved exchanges not provided by traditional tools.

The evaluation of these gains will have to be compared with the additional effort to deal with a computer system intended to support the post-meeting stage. The result may depend on the complexity of the meetings, the attitude towards technology from the participants, the quality of the human–computer interface of the system, as well as the value assigned to the gains. As we discussed in the previous section, the gains may not be apparent at first sight. An intermediate implementation may then be justified, as our case study shows.

Our approach calls for structuring the activities to be performed in the post-meeting phase. However, it should be noted that research done by Suchman (1983) has shown that plans, procedures and process models in office work play a weaker

role in providing guidance for situated action than was assumed by the proponents of workflow automation. Furthermore, Schmidt (1997) suggests that the procedural structure of such protocols can be thought of as the *result* of orderly work rather than its *determinant*. This could warn us about the difficulties to structure activities. Nevertheless, in our case, the activities to be carried out in the post-meeting phase have been already decided in the meeting phase; that means, the decision makers *envision* what should be done after the meeting. This does not imply the specification of the decisions and the persons to implement them is complete and unambiguous. On the contrary, implementers will probably have equivocality and uncertainty (Daft and Lengel, 1986) concerning the decisions.

Acknowledgements

References

Abecker, A., Decker, S., Maurer, F., 2000. Knowledge management and organizational memory. Information Systems Frontiers 2 (3–4), 251–252.

Apple Computer, 2003. Available from: <http://www.apple.com/ical/>, last accessed in March 2003.

Balasubramanian, P., Nochur, K., Henderson, J.C., 1999. Managing process knowledge for decision support. Decision Support Systems 27 (1–2), 145–162.

Barthélemy, J.P., Bisdorff, R., Coppin, G., 2000. Human centered processes and decision support systems. European Journal of Operational Research 136 (2), 233–252.

Borges, M., Pino, J.A., Fuller, D., Salgado, A.C., 1999. Key issues in the design of an asynchronous system to support meeting preparation. Decision Support Systems 27 (3), 271–289.

Casati, F., Castano, S., Fugini, M., Mirbel, I., Pernici, B., 2000. Using patterns to design rules in workflows. IEEE Transactions on Software Engineering 26 (8), 760–784.

Courtney, J.F., 2001. Decision making and knowledge management in inquiring organizations: Toward a new decision-making paradigm for DSS. Decision Support Systems 31 (1), 17–38.

Daft, R.L., Lengel, R.H., 1986. Organizational information requirements, media richness and structural design. Management Science 32 (5), 554–571.

David, J., Borges, M.R.S., 2001. Selectivity of awareness components in asynchronous CSCW environments. In: Proceedings of 7th International Workshop on Groupware. IEEE Computer Society Press, Darmstadt, Germany, pp. 115–124.

Kraemer, K.L., King, J.L., 1988. Computer-based systems for cooperative work and group decision making. ACM Computing Surveys 20 (2), 115–146.

Kunz, W., Rittel, H., 1970. Issues as elements of Information Systems. Working Paper No. 131, Institute of Urban and Regional Development, University of California at Berkeley.

Levitt, M., Mahowald, R.P., 2002. There should be More to Collaboration than Email. IDC White Paper, Report and Related Panel, last accessed in March 2003. Available from: <http://www.groove.net/extras/beyondemail/idc/>.

Lotus Workflow, Available from: <http://www.lotus.com/products/domworkflow.nsf>, last accessed in October 2002.

Nunamaker, J.F., Dennis, A.R., Valacich, J.S., Vogel, D.R., George, J.F., 1993. Group support systems research: Experience from the lab and field. In: Jessup, L.M., Valacich, J.S. (Eds.), Group Support Systems—New Perspectives. MacMillan, New York, pp. 125–145.

Nunamaker, J.F., Briggs, R., Mittleman, D.D., 1995. Electronic meeting systems: Ten years of lessons learned. In: Coleman, D., Khanna, R. (Eds.), Groupware: Technologies and Applications. Prentice Hall, New Jersey, pp. 146–193.

O'Leary, D., 1998. Enterprise knowledge management. IEEE Computer 31 (3), 54–61.

Proforma Corporation, 2003. Provision Workbench, Available from: <http://www.proformacorp.com>, last access in January 2003.

Russo, J.E., Schoemaker, P.J.H., 1989. Decision traps: Ten barriers to brilliant decision-making and how to overcome them. Simon and Schuster, New York.

Schmidt, K., 1997. Of maps and scripts: The status of formal constructs in cooperative work. In: Proceedings of GROUP'97. ACM Press, Phoenix, AZ, New York, pp. 138–147.

Shim, J.P., Warkentin, M., Courtney, J.F., Power, D.J.R., Sharda, R., Carlsson, C., 2002. Past, present and future of decision support technology. Decision Support Systems 33 (2), 111–126.

Simon, H.A., 1977. The New Science of Management Decision. Prentice-Hall, Englewood Cliffs, NJ.

Suchman, L.A., 1983. Office procedures as practical action: Models of work and system design. ACM Transactions on Office Information Systems 1 (4), 320–328.

Svenson, O., Benthorn, L.J., 1992. Consolidation processes in decision making: Post-decision changes in attractiveness of alternatives. Journal of Economic Psychology 13 (June), 315–327.

Svenson, O., 1992. Differentiation and consolidation theory of human decision making: A frame of reference for the study

of pre and post decision processes. Acta Psychologica 80, 143–168.

Tiwana, A., Ramesh, B., 2001. A design knowledge management system to support collaborative information product evolution. Decision Support Systems 31 (2), 241–262.

van der Aalst, W.M.P., ter Hofstede, A.H.M., Kiepuszewski, B., Barros, A.P., 2003. Workflow patterns. Distributed and Parallel Databases 14 (3), 5–51.

Wfmc, 2003. Workflow Management Coalition, Available from: <http://www.wfmc.org>, last access in January 2003.