Traceability and knowledge modelling

Smain Bekhti, Nada Matta

Tech-CICO, Université de Technologie de Troyes
12 rue Marie Curie, BP. 2060, 10010 Troyes Cedex, France
e-mail: {smain.bekhti, nada.matta}@utt.fr

Abstract.   A project memory is a representation of the experience acquired during projects realization. It can be gotten through a continuous capitalization of the enterprise activity, notably its design rationale. Most of capitalization methods don't allow a design rationale structuring in real time. We propose in this paper, a dynamic process of knowledge modelling, offering a way to keep track of Knowledge in two stages: direct transcription and structuring.

Keywords. Knowledge modelling, project memory, knowledge management, knowledge representation, design rationale.

1 INTRODUCTION

Knowledge management is a process of explicitation, modelling, sharing and appropriation of knowledge [1]. The majority of knowledge management methods aim at defining a corporate memory considered as a strategic asset of the organization. We can classify these methods in two main categories: knowledge capitalization methods and direct extraction methods (Figure 1).
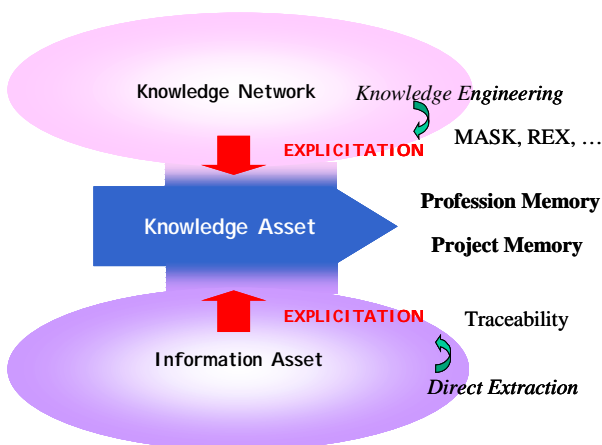

Figure 1 . Two techniques of explicitation of knowledge: capitalization and direct extraction

- The methods of knowledge capitalization use primarily techniques of knowledge engineering. These techniques consist mainly of knowledge extraction (experts interviews or collection from documents) and modelling. We can note for instance methods MASK, REX, etc.

- The direct extraction aims at extracting knowledge directly from the activity of the organization. We can distinguish several techniques as data mining (extracting knowledge using statistical analysis), text mining (extraction of knowledge based on linguistic analysis of texts [2]), techniques of traceability (e-mail, forum of discussion, etc) and design rationale.

We study in this paper, the traceability of the design rationale that aims at defining a project memory [3]. The principal problem in this traceability is the dynamic modelling, in other terms, how to formalize the data and information extracted in real time from the activity.

Dynamic modelling must also be realized in parallel with the organization activity. Therefore, this modelling should be integrated in this activity. In other terms, direct extraction and dynamic knowledge modelling introduce changes in the organization and the realization of a project.

Several methods of design rationale were defined. These methods allow keeping track of collective problem solving, especially those extracted in meetings of decision-making. The techniques recommended in these methods induce a consequent work. So they are less and less used in the organizations. The objective of our work is to define a method of dynamic modelling easy to apply, therefore a method easily integrated in the activity of realization of project. Our hypothesis is a decomposition of modelling in several stages, slightly transforming the activity of making notes and their organization. The method (Cf. 3) we defined is built by analysing an experiment of traceability of a project of definition of professional risks evaluation (in collaboration with National Institute of Research and Security «INRS» [4]) while being based on a study of the literature of the design rationale(Cf. 2).

2 TRACEABILITY OF THE DESIGN RATIONALE

Several methods were defined to represent the design rationale in a project. These methods can be classified in two principal categories: decision-making driven representation and problem solving dynamics representation.

2.1 The decision-making driven representation

In this type of approach, the design rationale, also named the analysis of the Space of design [5] is represented through the elements that influenced a decision-making. We can distinguish primarily the methods IBIS [6], DRAMA [7] and QOC [8] (the reader can refer to [3] to have more details about these methods).

The space of design is generally represented in these methods by design choices. These choices are structured like answers to the questions evoked by the design's problem. Arguments can justify the choices of an option according to a given criteria. The options generate other questions to which the designers answer by options.

2.2 Representation of the dynamics of problems solving

Some approaches offer a more global representation of the design rationale. Indeed, some elements of the context like the activity of the organization, the role of the actors and the artefact are represented. We can distinguish in particular the DRCS system [9]. It offers several views on a project: modules of the artefact, association of the tasks, evaluation of the specifications, decision-making, alternatives of design and argumentation.

Another approach consists of representing the design rationale based on cognitive analysis of a problem solving. We distinguish in particular DIPA formalism [10]. This formalism (Data, interpretations, proposals, agreement) use problems solving modelling defined in knowledge engineering to structure a decision-making. In DIPA, the model decision-making is represented in three major stages:

1. A first phase of description of the problem which allows collecting data, considered as symptoms in analyse situations or as needs in synthesis situations;

2. A second phase of abstraction which starts from data problems in order to find to them an interpretation corresponding to a possible cause in the analysis situations or with a functionality of solution in the synthesis situation;

3. A third phase of implementation which starts from the interpretation (cause or functionality) and which allows to elaborate a proposition which will take the form of a repair removing the cause of the symptom (analysis) or a means responding to the expressed functionality (synthesis).
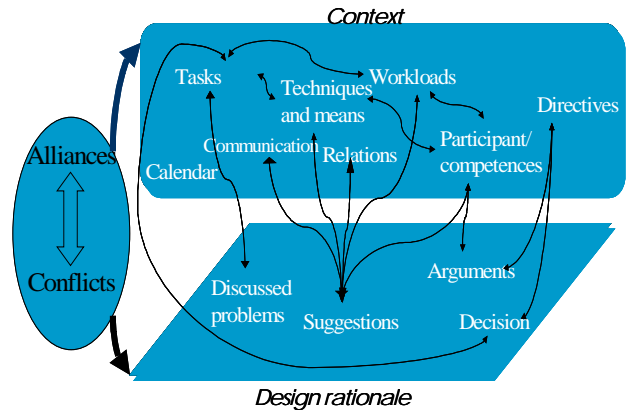
2.3 Discussion

Figure 2 . Mutual influences between elements of the project

A project memory must contain elements of the experience Coming as well as from the context and from the problem solving. These elements have a strong mutual influence so that if the context is omitted, the restitution problems solving is insufficient.

We often observe this type of phenomena in the results obtained with the approaches quoted above. Except the system DRCS, some approaches defines techniques to represent this influence between the context and problems solving in a project. Even DRCS system can only allow representing a part of this context (the tasks organization and the projection of the decisions on the artefact). In the same way, we can observe some efforts in DIPA formalism to represent the organization of work in a workflow (task/role). However, also other elements have to be identified like constraints, directives, resources and competences, modes of communication, etc. We consider in our approach representing a complete vision of the project context by emphasizing its influence on the problems solving.

In other way, the representation of the problems solving as it is suggested by the approaches noted above, remains incomplete as a representation of the space of negotiation between the project actors. Indeed, the first type of approaches rather allows a representation driven by the decision in order to show only the elements that influenced a decision. In the second approaches type, an effort is made to represent the dynamics of the decision-making. However, a negotiation is a space of discussion between several actors where various objectives are confronted, alliances and conflicts are constituted. In the same way, a negotiation has a history and is influenced by the alliances and the decisions made during the last negotiations. Our approach permits to keep in memory this dynamics of negotiation so that its restitution is easy to show the various elements included in a resolution of problem.

Finally, the application of the design rationale methods proved their difficulties in real time. In fact, it is no evident to note all the enunciations and to analyse and structure discussion directly during the meeting. Modelling a-posteriori presents a significant risk of missing arguments and elements that influenced the decision-making. We propose in following, an approach proceeding by progressive stages for a direct traceability and a modelling of the negotiation.
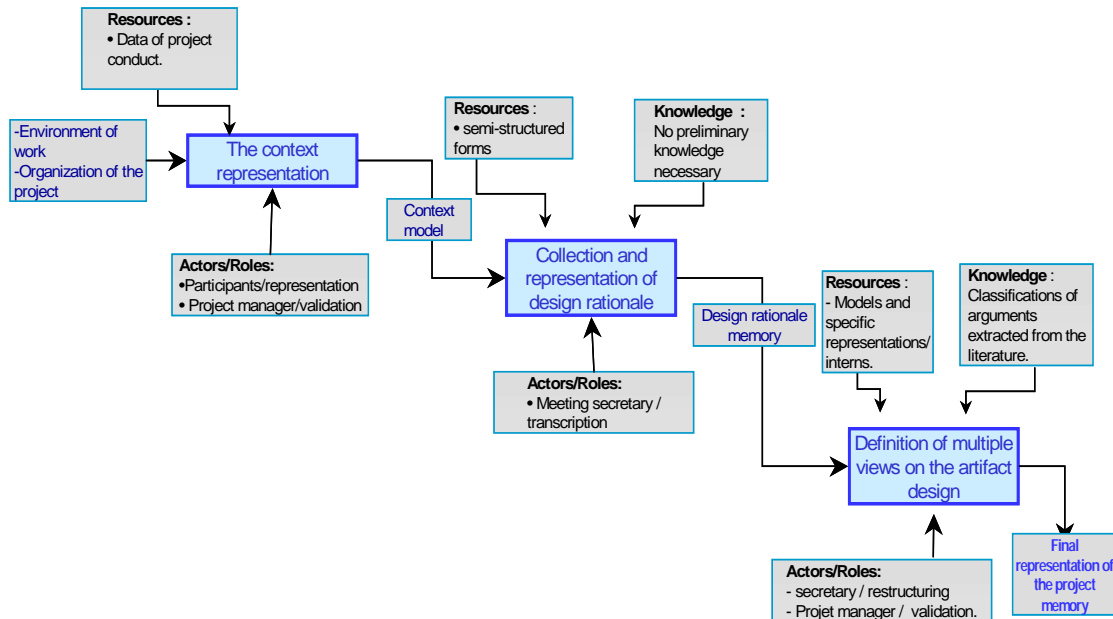

Figure 3. Model of traceability process

this step: context representation, transcription of the design rationale, restructuring and multiple views definition (figure3).

3 DYNAMIC PROCESS OF KNOWLEDGE MODELLING

The dynamic process of knowledge modelling we defined is based on a method permits to obtain a structured track of a project memory as well as the context and decision-making. The principal objectives of the method are on the one hand, to make possible its application in real time and keep track of meeting and on the other hand to structure knowledge extracted so that it can be easily reusable. We thus defined three principal stages in

3.1 Context representing

We represent the context of a project (Figure 4) as a description of the work environment (means and techniques, referential, instructions and constraints of the project) and the project organization (participants, their roles and tasks organisation).
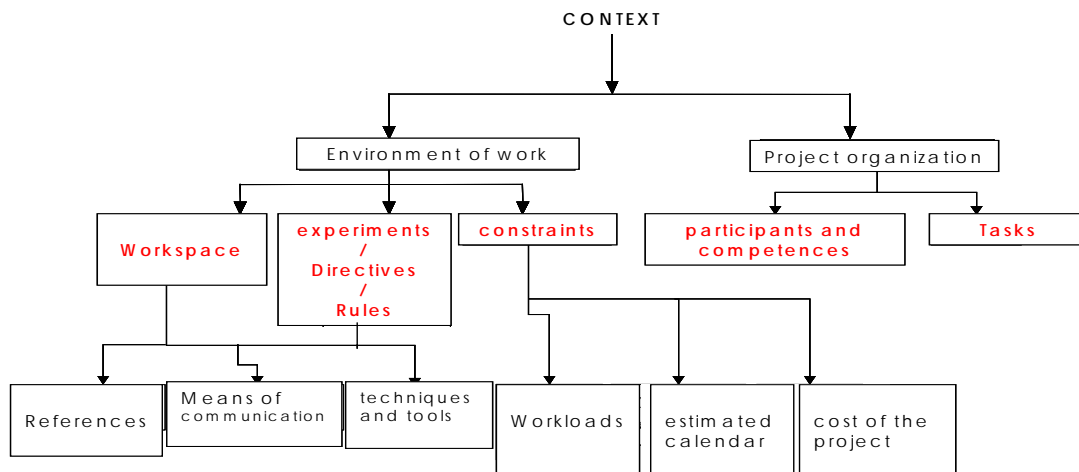

Figure 4. Representation of the context

We present in figure4 some elements of the context that can be represented in several levels of structuring, to show different aspects of influence between its elements and the design rationale.

3.2 Extraction and representation of the design rationale

3.2.1   Direct transcription

The approaches of design rationale generally require a deep analysis to model decision-making. So they are not easily applicable in real time. The first stage of our approach consists of a transcription guided by a form where the basic elements as problems, argumentation and decision can be classified. These forms can be used to note in a structured and rapid way all the data elements that can be collected during a negotiation (Figure 5). The objective is to prepare a structured transcription of the negotiation during meetings and in real time. The structure of these forms permits to distinguish the elements of the discussed problem, to highlight the arguments of the participants to the meeting and their possible suggestions.

Notes are structured initially by participants who, during the meeting, are recognized either by their names or by their visual aspects. In fact, the direct transcription that we propose, follows on the one hand, the traditional methods of notes taking in meetings and on the other hand prepares the structuring of knowledge.

This transcription can be easily realised by a meetings secretary. No deep analysis is required in this type of transcription. Note also that a chronological recording of the negotiation is backed up in this type of transcription.
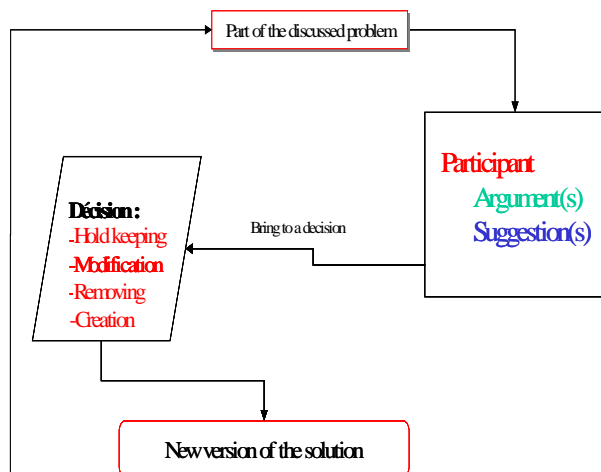

Figure 5 . Form used for the direct transcription of a negotiation

3.2.2   Content structuring

The principal objective of a structuring is to allow an intelligent access to the knowledge of the memory. We propose to provide several accesses to the memory according to various prospects that we define later on. The second stage of our approach consists of a structuring based on a cognitive analysis of the forms filled out during the direct transcription. We were inspired by the approaches of design rationale to define a structure of representation (Figure 6) putting ahead the influence elements of a negotiation, such as argument, criteria of justification and suggestion. The identification of the criteria is guided by a classification of the argument types. The method that we propose can be compared with meetings reporting where the direct transcription is similar to the notes making and the structuring to the summary report. However in our case, the notes taking is guided and the result is richer and reflects a more complete memory of the negotiation and the decision-making.
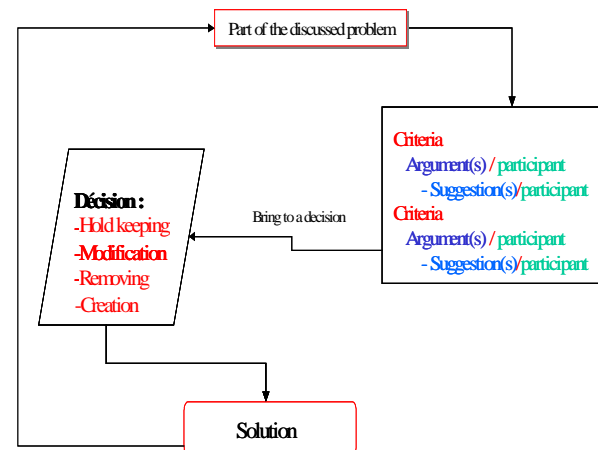

Figure 6 .   Form used for the negotiation structuring

Some criteria, definite during this structuring, can be regarded as simple to identify and could be used to enrich the structure of the direct transcription (used in future meetings) and to facilitate the structuring. It's in this sense that we consider our method like dynamic process acting at the same time on the method and the structure.

Our main objective is to integrate the traceability of decisions in the process of realization of projects. The approach that we propose introduces a slight change into the organization of a project in order to make this traceability possible.

In order to guarantee a representation of the deep knowledge which have influence the design rationale, the validation meeting after some project phases and at the end, especially with some participants who have got a global vision of the project (for example, the project manager), must be hold. These permit to reformulate the arguments, the suggestions and the criteria and to re-examine their classification. The structure of the memory encourages the participants to clarify their knowledge, enriching by that the contents of the memory.

3.2.3   Logic of the structuring form

The structure represents the logic of discussion. Participants discuss each part of the problem by giving their opinions supported by several types. The participants can also give suggestions concerning the part of the problem. The whole arguments and suggestions allow the group to make a decision concerning this part of the problem. The part of the problem is thus solved, otherwise it will be discussed again

in the same manner and it will pass by the same cycle. So we will be able to see the evolution of this element during the discussion until its final version.

In the structure, the arguments are classified according to their type or their nature. Each argument or suggestion is related to the participant who emitted it. Knowing that for each participant his competence and his role are described, that permits to see the relation that can exist between the contributions (arguments, suggestions) of the participants and their competence.

Elements of the structure

Problem objects: The global problem discussed during the meetings is composed of sub-problems or elements of problem. The idea is to break up the whole discussion into basic elements. The structure thus permits to represent these elements of discussion with their contents, to bind between them and to represent the evolution of each of them during the negotiations.

Arguments: One of the most significant elements of any negotiation is the argumentation. In our approach the argumentation is an essential element of the representative structure because it is the origin and the cause of the evolution of the discussion of the problem and consequently of the decision-making.

Suggestions: The arguments advanced by the speakers during meetings often lead them to make their own suggestions concerning such or such part of the discussed problem, we envisaged in the model a space for the suggestions of the participants. The suggestions are related to the arguments and the participants who proposed them.

Participants: The representation of the participants in the structure is important, it permits to bind the arguments and suggestions to their transmitters. Each participant is characterized, primarily, by his competences and his role in the project (see context). It permits to really understand the logic and the reasoning of the participants and the motives of their interventions.

3.3 Definition of multiple views

The design rationale as it is generally defined, represents the space of decision in a project. We propose to describe this space in various points of view while focusing on the negotiation that takes a central place in the design rationale. The majority of these points of view can be generated automatically from structuring forms. We identified four points of view: Point of view of problem solving, Point of view of argumentation criteria, Point of view evolution of the problem solving and chronological point of view. We study other points of view that permit to shows the links between the participants and the problem solving [11].

3.3.1 Point of view of problem solving

This point of view is based primarily on the structured forms corresponding to the elements of the problems treated.
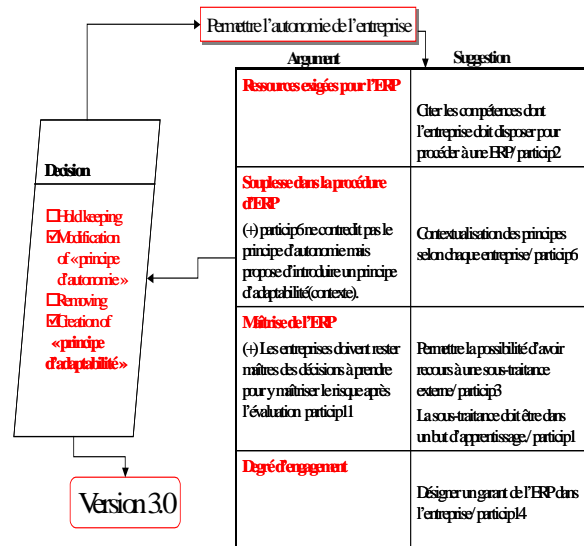

Figure 7 . Example of a point of a view on the problem solving [4].

3.3.2 Point of view of argumentation criteria

A view extracted from the criteria of argumentation shows a synthesis of the key elements that influenced the problem solving and from through that the decision-making. This view presents the relations between the criteria, the advanced arguments and the arising problems.
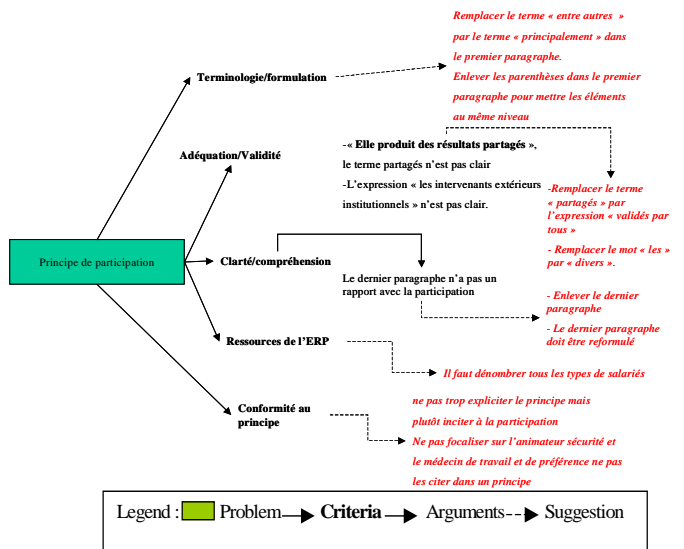

Figure 8 . Example of a view by criteria

3.3.3 Point of view evolution of the problem solving

The evolution of the decisions is an important element to memorize in the design rationale. We put the evolution of the problems forward while joining the problem to its solution that can also generate other problems.
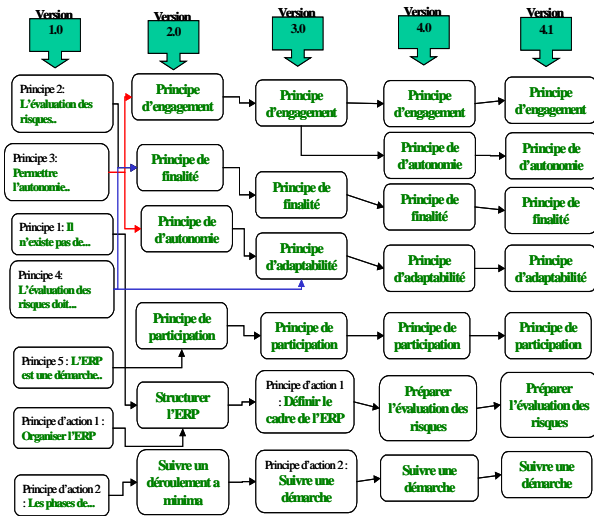
Figure 9 . Example of a view on the evolution of the artefact (principles of assessment of the professional risks).

3.3.4 *Chronological point of view*

The transcription forms can offer a chronological view on the progress of the negotiation. Indeed, from this chronological representation, we can reach at any phase of the evolution of the problem solving. The representation of the task process in the context as well as the link between these tasks and the forms provide a global view on the progress of the project.
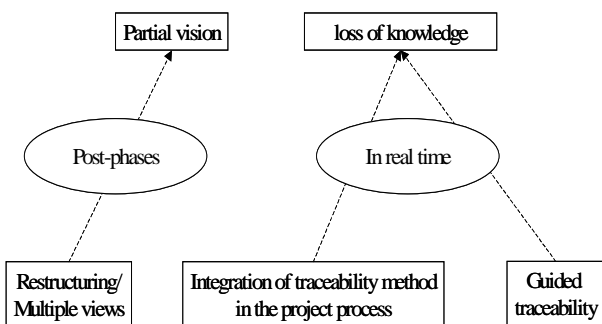
4 CONCLUSION

Figure 10 . The solutions brought by our approach to the limits of traceability methods

A project memory reflects an acquired experience, it must represent all elements of information related to the project, as well as the context and the design rationale. We describe in this paper an approach that permits a global representation of these elements. It puts forward the elements and the mutual relations that influence the problem solving in a project and that through views representing the different faces of the project progress.

The approaches of traceability of the design rationale present some limits in the modelling during the activity. These limits are linked essentially to the difficulty in identification and classification in real time questions, suggestions, types of arguments, etc. during meeting. We proposed a dynamic process of modelling based on several phases starting from a semi-structured note taking toward a more advanced structuring. The structure of representation evolves the problems evolution.

Our approach is based on a representation similar to the approaches of design rationale. Indeed, the decision-making is described with key words as: problem, arguments, suggestions, etc. As we showed it in this paper, it integrates easily in the project process without requiring specific expertises. It is based on as well as knowledge traceability in real time and a-posteriori analysis that permits to get a deep representation of knowledge. Thus, allows having a global vision of the project (figure10). Let's note that the process of modelling is based on an abstraction guided by classifications and structures.

We defined this approach while being based on a real experience (the project of definition of the principles of assessment of the professional risks) and we plan to validate it on other fields of application.

The representation of the context in our approach is not developed enough, we examine other studies of the context especially mathematical and sociological representation. The pragma-linguistic works can enrich the representation of the communication in a memory of project, in the same way, the socio-organizational studies are very important to identify the interpersonal relation and their role in the decision-making.

We develop a tool to support our approach offering, on the one hand, a flexible structure of representation and on the other hand an adaptive user interface.

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