Memory Meetings
An Approach to Keep Track of Project Knowledge in Design

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Keywords: Knowledge Management, Project Memory, Traceability, Design Project.

Abstract: Design projects are cooperative activities in which several actors from several fields work together in order to rich a goal. The challenge is how to keep track of knowledge from daily work in this type of activity. Projects documents are not sufficient to be analysed to extract this type of knowledge. This paper presents techniques to acquire and represent knowledge from design projects. A specific approach has been developed in order to keep track of meetings and to link design rationale to organizations elements and to results of a project. This approach has been integrated to designers' environment using Product Life Cycle Tool.

1 INTRODUCTION

To enhance learning in an organization, the knowledge modelling has to emphasize the know what and know how (Colin, 1998); (Nonaka et al., 1995). "The learning content is context specific, and it implies discovery of what is to be done when and how according to the specific organizations routines" (Easterby-Smith et al., 2007). So, the context in which the knowledge is produced has to be also represented as same as knowledge "knowing what" and "knowing about". For instance, representing ontology tends to emphasize not only concepts but also documents source of these concepts (Guarino, 1998). However, sharing documents, information and experiment without structuring of this information and feedback analysis as used currently on social network as support of knowledge sharing, is not sufficient to enhance learning. In fact, the how is shared but not the what. Behavior laws provide strong semantics to emphasize reason of expert's behavior, ready to be reproduced to solve new problems.

In our work, we aim at representing the "knowing what" and "knowing about" of a cooperative activity. In other terms, we tend to emphasize knowledge produced in a cooperative activity (design projects) and its context. We propose then to focus on what is debated during cooperative activities rather than on knowledge management methods, which mostly tend to define the "common ground".

The challenge is how to extract knowledge from a project organization that is a virtual one. In fact, project organization is defined at the beginning of the project and dissolved at the end. Actors of this type of organization are belonging to different companies. Otherwise, project documents are not sufficient as sources to extract project knowledge and especially collaborative decision-making.

We propose in this paper an approach to keep track and structure knowledge produced during design project realization, using designers' workspace.

2 HOW TO REPRESENT COOEPRATIVE ACTIVITY KNOWLEDGE?

We distinguish knowledge related to a given field or business from knowledge related to cooperation:

- The nature of knowledge is different: The business knowledge is related to a field and contains routines and strategies developed individually from experiences, which involve a number of experiments. The cooperative knowledge is related to several fields, i.e. several teams (of several companies) and in several disciplines collaborates to carry out a project. So there is a collective and organizational dimension to consider in cooperative

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knowledge. Representing domain knowledge consists in representing the problem solving (concepts and strategies) (Castillo et al, 2005). On the contrary, emphasizing knowledge in cooperative activity aims at showing organization, negotiation and cooperative decision-making (Djaiz et al, 2006). Otherwise, knowledge observed in a corporative constitutes one experiment to be structured.

- Capturing of knowledge is different: The realization of a project in a company implies several actors, if not also other groups and companies. For example, in concurrent engineering, several teams of several companies and in several disciplines collaborate to carry out a project of design. The several teams are regarded as Co-partners who share the decision-makings during the realization of the project. This type of organization is in general dissolved at the end of the project (Matta et al, 2000). In this type of organization, the knowledge produced during the realization of the project has a collective dimension, which is in general volatile. The documents produced in a project are not sufficient to keep track of this knowledge. In most of the cases, even the project manager cannot explain it accurately. This dynamic character of knowledge is due to the cooperative problem solving where various ideas are confronted to build a solution. So acquisition of knowledge by interviewing experts or from documents is not sufficient to show different aspects of the projects and specially negotiation (Bekhti et al., 2003). Traceability and direct knowledge capturing are needed to acquire knowledge from this type of organization.

Based on this distinction, we propose to study PLM platforms for identifying what is and what should be for enabling cooperative knowledge and project memory.

3 PROJECT KWNOLEDGE REPRESENTATION

A project memory describes "the history of a project and the experience gained during the realization of a project". It must consider mainly (0):

- The project organization: different participants, their competences, their organization in sub-teams, the tasks, which are assigned to each participant, etc.
- The reference frames (rules, methods, laws ...) used in the various stages of the project.
- The realization of the project: the potential problem solving, the evaluation of the solutions as well as the management of the incidents met.
- The decision making process: the negotiation strategy, which guides the making of the decisions as well as the results of the decisions.

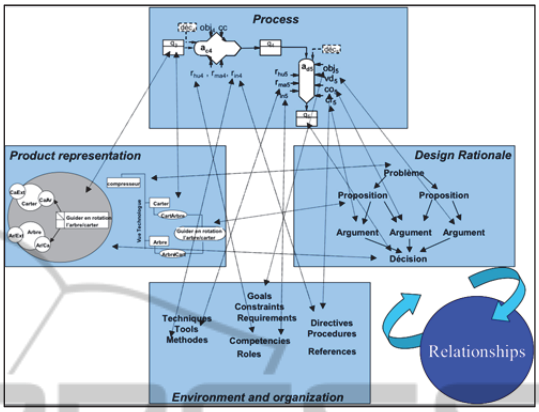


Figure 1: Project memory.

Often, there are interdependent relations among the various elements of a project memory. Through the analysis of these relations, it is possible to make explicit and relevance of the knowledge used in the realization of the project. The traceability of this type of memory can be guided by design rationale studies (Karsenty, 1996) and by knowledge engineering techniques (Matta et al, 2000).

3.1 Decision-making Representation

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

3.1.1 Decision-making Driven Representation

In this type of approach, the design rationale, also named the analysis of the Space of design (Buchingham Shum, 2005) is represented through the elements that influenced a decision-making. We can distinguish primarily the methods IBIS (Dieng et al., 1998), and QOC (Maclean et al., 1991), (Buchingham Shum, 2005).

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.

3.1.2 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 artifact are represented. We can distinguish especially, the DRCS system (Klein, 1993). It offers several views on a project: modules of the artifact, association of the tasks, evaluation of the specifications, decision-making, alternatives of design and argumentation. Some models are also defined in order to emphasize dynamic problem solving. We note especially the DIPA model (Lewkowicz et al., 2002). This model takes into account the transformation of problem definition and constraints into propositions, argumentation and solutions.

3.1.3 Discussion

A project memory must contain elements of the experience coming as well as from the context and from the problem solving. Context is important to enhance learning in an organization (Easterby-Smith et al., 2007). There is a strong mutual influence between context and solutions. So that if the context is omitted the restitution of 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 do not define techniques to represent this influence between the context and problems solving in a project. Even DRCS system only enables the partial representation of this context (the tasks organization and the projection of the decisions on the artifact). In the same way, we can observe some efforts in DIPA formalism to represent the organization of work in a workflow (task/role). However, other elements have to be identified like constraints, directives, resources and competences, etc. We consider in our approach representing a more complete vision of the project context by emphasizing its influence on the problems solving.

However, 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 type of approaches, 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 allows users keeping in memory this dynamics of negotiation so that its restitution is easy to show the various elements included in problem solving. We define first a project memory structure that allows representing several concepts that will be consider in project memory and their mutual influence.

3.2 Representing Structure of a Project Memory

As we noted above, project memory has to consider from one side, several dimensions like: organization, problem context and definition, negotiation and cooperative decision-making and from the other side, semantic and cognitive representation like: “know what” and “know how” (Colin, 1998). In fact, to enhance learning from project organization, it is necessary to emphasize how and when activities are conducted and also what and why these activities are conducted (Easterby-Smith, 2007). We consider these two aspects in a structure to represent a project memory. The organization description (how and when) can be directly traced from design activity (0). We find this information in design environment and tools: documents, discussions, process, product, etc.

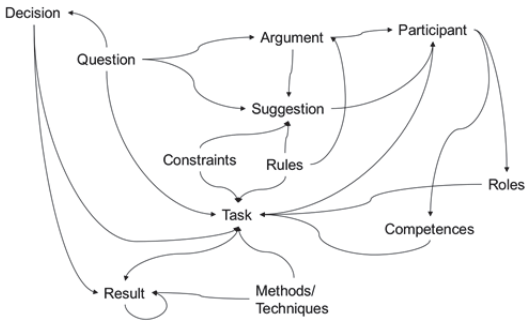


Figure 2: Concepts to represent in a Project memory.

Representing of the semantic aspect of project organization needs analysis and abstraction. Most knowledge management methods focus on the definition of the “common ground”. In our approach, the relation between cooperative decision-making and elements in project organizations are emphasis and are the central point of our proposition. The interest is then to structure the project memory (Bekhti et al., 2003). Mainly emphasizing the characteristics of suggestions and decision can do

this relation, using criteria. We use the DYPKM approach (Bekhti et al., 2003) to extract criteria from decision-making meetings and to define links between criteria and project elements.

Example of such links are shown in (0). This example are extracted from a project that aims at proposing a number of principles that can guide companies to evaluate their risk in their activities (Bekhti et al., 2003).

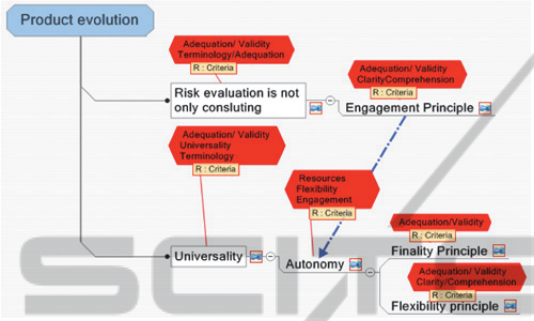


Figure 3: Links between criteria/decision and solution emphasize why of product evolution and the final solution. For instance, to solve the problem about Risk evaluation actors decide to define an Engagement principle. We show how they decide that by representing the main criteria of the decision: “Adequation, Validity and Clarity”.

DYPKM approach recommends keeping track of design rationale from the project context and decision meetings. Traceability of decision-making has to be done on two steps taking notes during the meetings and structuring notes to define report. Secretary in a meeting has to take notes of discussions in order to keep track of links between these discussions, questions and participants. When writing report, he/she has to distinguish suggestions from arguments and to annotate them by criteria. Example of such links are shown in (0).

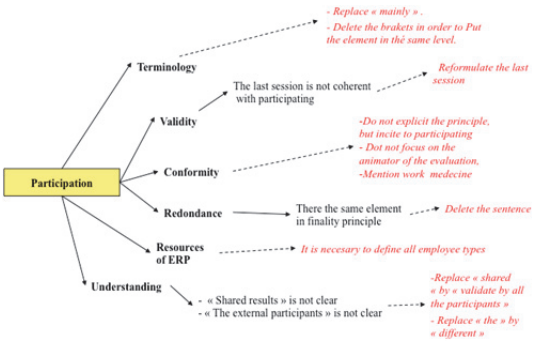


Figure 4: Meeting Report structure using DYPKM (Bekhti et al., 2003). This structure shows mainly relations between question, propositions of solutions and arguments (red text). Criteria (as notes in links) sum up main characteristics of propositions and arguments.

In order to obtain this type of results and to integrate traceability during an activity, we define a tool (Memory Meeting) that supports collaborative decision-making traceability. Results are then linked to other project parts using designers’ tools like Product Life cycle management tools (PLM).

4 MEMORY MEETINGS

The principle of our work is to structure a meeting result on questions, suggestions, arguments and criteria. Links to participants who enunciate suggestions and arguments must be also recorded. Based on first tests of DYPKM (Bekhti et al, 2003) on real applications, we identify that secretary cannot take notes and structure them as the same time. So, we propose on our approach:

- First, secretary can take notes during the meeting, showing questions, discussions, participants and decisions
- Second, when he/she makes the meeting report, he/she should identify suggestions, arguments from discussions and define criteria. In general, in projects, head of projects does generating reports. Elsewhere, distinction between suggestions, arguments and identifying criteria will be done by the project responsible.

In order to integrate collaborative decision-making traceability in the project activity, we use mobile equipment, like smartphone and organizer as support of our tool. Nowadays, a lot of people have a smartphone, so, we develop an application on an IPhone that help to record and take notes during the meeting. This application builds links between questions, discussions and participants. Questions can be extracted from the schedule of the meetings, in the same way, participants can be added from the meeting organization.

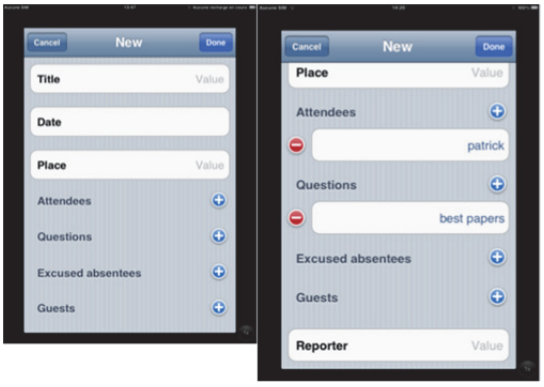


Figure 5: Prepare meeting using Memory Meetings.

This information can be directly obtained from project management tool through an XML file. Secretary also can directly put information about meetings in the Memory Meeting application (0).

4.1 Memory Meetings Record

During the meeting, secretary, can select the question to be discussed, select participant who speak and record and take notes at the same time. (0).

Figure 6: Discussions record linked to participant and question.

So, notes and record are linked directly to the selected question and participant. He/she can select easily another participant, or another question.

Results of the meetings can be directly extracted as XML file and/or used later to define the meeting report.

4.2 Memory Meetings Report

Secretary uses Memory Meetings application to define a report. Our aim on traceability is to keep track not only link between question, discussions and participants but also to structure discussions in order to identify suggestions, arguments. The QOC (Maclean et al, 1991), approach shows that identifying criteria is important. They put on the main characteristics of discussions. We show in Figure 3, how criteria are important to index the evolution of the design. We define a set of criteria based of an analysis of design problems (Matta et al, 2000). Criteria can concern the proposition and the project strategy (0).

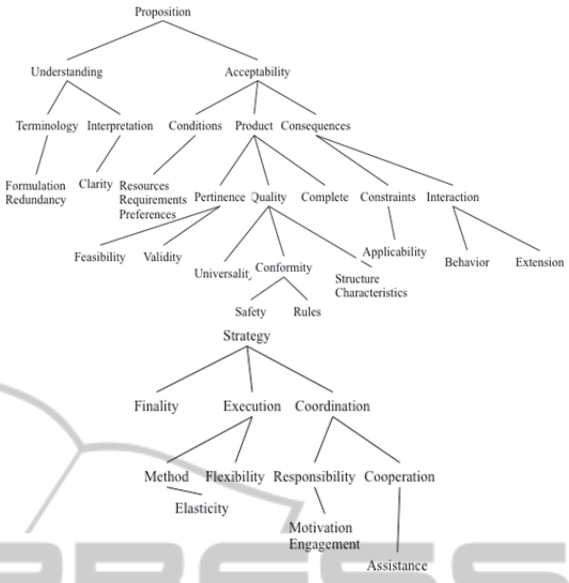
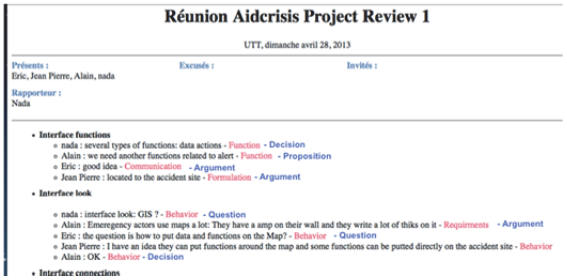


Figure 7: Design project problems (Matta et al., 2000).

So project responsible can directly annotate discussions by criteria using Memory Meetings application (0). Criteria can be also modified related to project type. We guess that small interface of Smartphone is not easy to use for this activity. So, Memory Meetings is also available on Ipad.

Figure 8: Identifying arguments, Suggestions and annotating them by criteria using Memory meetings application. Project responsible can read and modify notes and hear record related to each question and participant. He has to annotate related notes by a criteria and the discussion type (suggestion, arguments, decision, etc.).

The result of this work is under two aspects: a XML file, which will be integrated in project management tool, and a MsWord Report (0).



Réunion Aidcrisis Project Review 1

UTT, dimanche avril 28, 2013

Présents : Eric, Jean Pierre, Alain, nada — Excusés : — Invités :

Rapporteur : Nada

- **Interface functions**
  - nada : several types of functions: data actions - Function - Decision
  - Alain : we need another functions related to alert - Function - Proposition
  - Eric : good idea - Communication - Argument
  - Jean Pierre : located to the accident site - Formulation - Argument
- **Interface look**
  - nada : interface look: GIS ? - Behavior - Question
  - Alain : Emeregency actors use maps a lot: They have a amp on their wall and they write a lot of thiks on it - Requirments - Argument
  - Eric : the question is how to put data and functions on the Map? - Behavior - Question
  - Jean Pierre : I have an idea they can put functions around the map and some functions can be putted directly on the accident site - Behavior
  - Alain : OK - Behavior - Decision
- **Interface connections**

Figure 9: Example of Generated Report from Memory Meetings Report. We note discussion structuring: Question, Participant, criteria (red text) and discussion type (blue text).

5 INTEGRATE DECISION-MAKING TRACEABILITY IN PLM

A product Life cycle Management is defined as "a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise from concept to end of life - integrating people, processes, business systems, and information.» «PLM holds the promise of seamlessly integrating and making available all of the information produced throughout all phases of a product's life cycle to everyone in an organization, along with key suppliers and customers.» (Sudarsan et al., 2005). So, a PLM platform allows managing the product data along its life cycle process: specification, design and manufacturing and requires efficient traceability functionalities, often based on the definition of standards (Ducellier et al., 2006).

In a PLM, The product development is represented as a decomposition of objects. Each object is described by its parts (components), description documents (specifications, propositions, etc.) and dynamic documents (CAD, etc.). For each part's problem, a report (if needed) is defined by the designer. A Modification workflow is then generated corresponding to the problem report (0). This workflow is decomposed by decision-making and modification phases (Matta et al., 2011). The impact of the problem is calculated and related project members are asked to decide about the modifications and considering its impact. Meeting and/or using a vote system can do decision-making. When the decision is made, modifications can be performed to the part.

Figure 10: Product representation in a PLM.

When a problem generates a modification workflow, we have an access to members that will contribute to the decision. The decision is represented in a report. So, the result of Memory Meetings can be directly integrated as a modification decision related to the concerned part. The XML file result of memory Meetings report, is then treated in order to integrate links between decisions, participant, suggestions, arguments and question (the problem part) as a modification report. Related criteria is directly linked to product modifications (0).

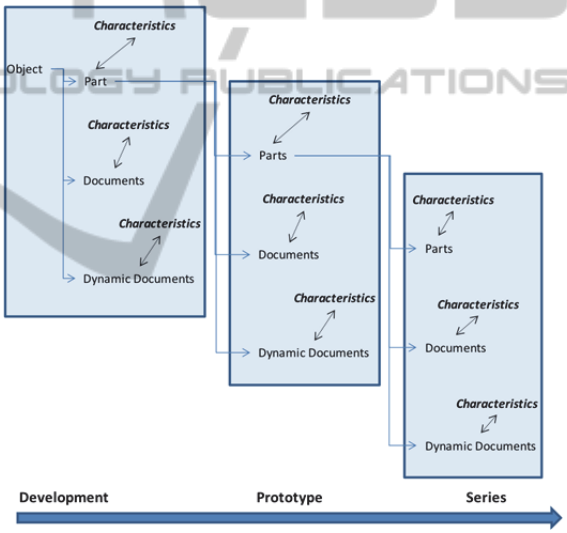


Figure 11: The characteristics annotation of the product evolution.

0 shows an example of the integration of criteria in the design cycle of a "PHILIPS Camera" using Windchill, a PLM tool developed by PTC (www.ptc.com): specifications of the front of the camera: buttons, display, etc.

This criteria annotation provides a first structure of the product evolution. Based on that and using links between project elements, we can extract several views about the design of the product. For example, the reason of a result based on the project organization: members' profile and roles and tasks, why such result for this requirement, etc.

In Windchill, there is no representation of the evolution of tasks. In fact, tasks are represented in a

planning and linked to members and objects. But the evolution of the planning is not enhanced in Windchill. In order to respect our project memory structure we plan some changing in the PLM in order to handle as same the evolution of the project as the product. In the same way, we have to keep a structured track of this evolution. So, as we proposed a structuring of the product using characteristics, criteria will be also used to characterize decisions on tasks and project members.

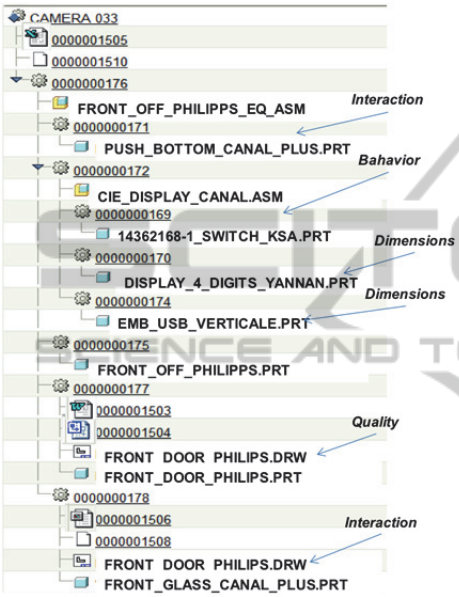


Figure 12: Example in Windchill: specifications of the front of a "PHILIPS" Camera. We note that the reasons of modifications are showed: dimensions, Behaviour and Interaction problems, quality requirement, etc.

6 CONCLUSIONS

Knowledge management techniques to handle a cooperative activity are not the same as individual one. Knowledge in cooperative activity is related to organizational dimensions as coordination, competences, roles and negotiation. Individual activity produces professional knowledge explained by tasks and concepts. Making explicit of knowledge in cooperative activity cannot use the same approaches (CommonKADS (Shreiber et al., 1995), MASK (Matta et al., 2001) recommended in profession KM, due to the virtually cooperative activity organizations.

We propose in this paper to study a KM approach in design project, which are a type of a cooperative activity. This approach recommends traceability and continuous knowledge structuring which has to be integrated in the actors' workspace. From one side, we define Memory Meetings application in order to keep track of decision-making from meetings and in another side; we integrate traceability in designers' workspace using PLM.

First tests are done in order to check the feasibility of our approach, but, we have to extend tests in order to validate traceability in real project organizations. For that, we work with a company (PI3C) that loan PLM services.

We also aim at integrating project memory in other project management tool and other type od design, for instance software engineering platform.

Results obtained from in this study are a first step in knowledge structuring; we aim at using classification and aggregation techniques in order to define typologies of cooperative activity knowledge.

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