Relation-Based Groupware For Heterogeneous Design Teams

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This paper describes a work about coordination of concurrent engineering in the building construction and design. More particularly it describes the coordination of project teams which are heterogeneous and short-lived. The French context of the building trade is at present characterized by an increase of the quality requirements and by a reduction of the conception and realization delays. This induces the building sector to look for new modes of cooperation as they already exist in industry and services. With a few exceptions, the concurrent engineering tools taken from these sectors are not used in building projects. We make the assumption that the lack of use of these tools is due to the non-fitting of the common existing tools to the specificities of our sector.

The solution we propose give a relational vision of the cooperation and the interactions existing during the processes of conception-construction in architectural works. Our first interest point concerns the representation of the actors, the documents and the assignments as a relational network and not as a hierarchical tree, mostly used in the groupware tools. In a second point, we use this relational network to produce a graphic and dynamic representation of the projects.

The goal of this method is to reinforce the co-operation and the group awareness by supplying to the actors a good vision of the project evolution in order to increase the conception quality.

Keywords: *concurrent engineering, groupware, project management, relational model, awareness*

Introduction

The very large building sites, from pyramids to cathedrals, were historically the first places of an empirical development of production collective practices.

A major characteristic of these practices was their surprising flexibility. Their systems of exchange and decisions, which were slightly hierarchized and codified, allowed adaptive managements with a great efficiency [Gimpel J.]. This ability to match numerous working contexts allowed these systems to exist during several centuries.

The development of industry in Europe during the XIX-TH century introduced a rupture. Using military practices developed in arsenals and royal factories, the industry defined command rules and hierarchical organizations [Bernoux, P.] between professions and men.

We think that this fact of history is the foundation of two paradigms of collective work. The first one is the paradigm of the cooperative exchange where the actors coordinate their activities in an implicit way according to the advancement of the project. The second one is the paradigm of the commanded

exchange in which the activity is planned a priori and the coordination among the actors is explicit. They are two forms of collaborative works based on different economies, relations and exchanges.

Today, these two approaches still exist even if the distance between both work models has decreased. We think that the failure of the use of the concurrent engineering methods imported from the industry domain to the building world is not due to a lag of the building domain, but rather to an original context of cooperation.

The multiplicity of techniques, the complexity of construction sites and the quality requirements begot more organized and controlled forms of building work. In this particular context, we think that the aiding tools for cooperative work in the building domain should propose an explicit coordination of the project based on an implicit coordination [Godart C.].

In this article we propose a model of collaboration based on this last principle where the representation of the cooperation depends on the relational organization of project actors. We show the advantages of such an organization with regard to the hierarchical organizations usually proposed in the commercial groupware tools.

Building context

The groupware and workflow tools developed in the industrial world can not be adapted directly to the building. They require a high level definition of procedures and exchanges which is incompatible with the big flexibility of the current practices. Our model founds itself on the principle of a vision by project which shows, in a dynamic way, a representation of the design team and documents that the project produces throughout its life.

The French building context distinguishes itself from the industrial world by :
• The multiplicity and the variety (in size, in means and in method) of the different actors ;
• Contractual links between the participants that exist only during a building operation;

• Very Empirical exchange manners of information where the oral expression plays an important role;
• Actor system which keep up dependence relations that are slightly hierarchized;
• Rich competences with limits that often remain vague;
• The non-routine character of the processes used in the design and in the project management of works which are often prototypes.

Experiment of a hierarchical model

The data hierarchical model is used by most of the current groupware tools, dedicated or not in the building trade (BSCW, Teamwave, Buzzsaw, ...). In order to show the lacks of systems based on a hierarchical management, we studied a groupware tool used during the conception of an urban planning project.

To realize this experiment we used a non-specialized groupware (BSCW from GMD-FIT) [Bentley, R.]. Regarding to the needs we have identified, the possibilities offered by this tool reflect the features [Salvador T.] proposed by the major part of groupware tools we have analyzed. For this research we have not considered the ergonomic features of the software, the actors being trained with the use of the chosen tool.

The context

Several actors groups participate to this project : an architect office, technical experts of the town council and a neighborhood committee. The project lasted 6 months and allowed us to verify the hypotheses we have formulated on the hierarchical model.

A quality management plan, based on the iso 9000 specifications, is supplied to the participants. This plan contains the file naming, file sharing and file validation rules. This document is essential to preserve a coherence of the data and make possible the information sharing between an heterogeneous project team (fig 1).
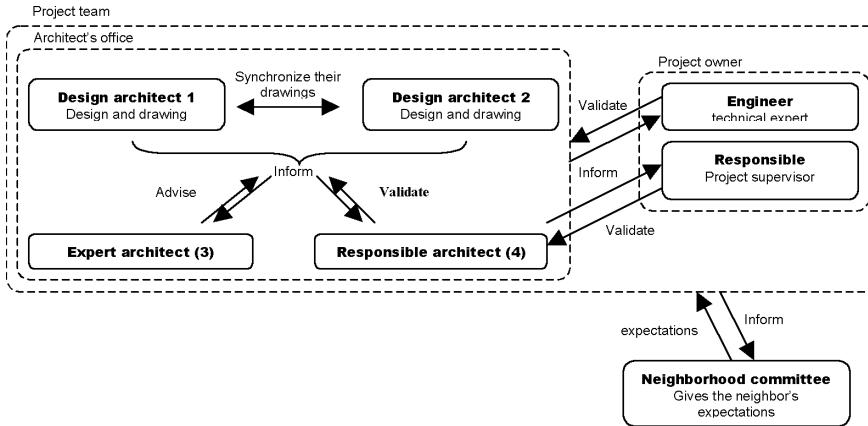
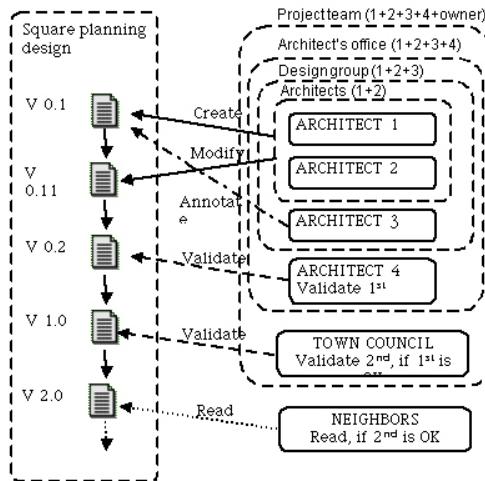*Figure 1. Relations between actors during the conception.*

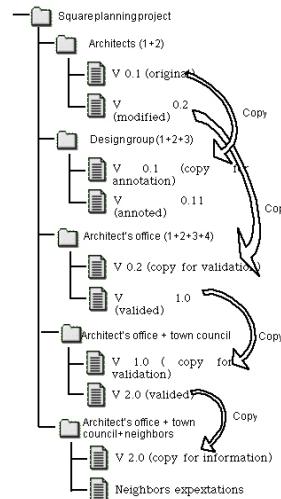*Figure 2 (left). Example of a document validation sequence.*

Figure 3 (right). Implementation of the example in a hierarchical data organization.

The progress

This case study showed us the relations and the roles held by the actors during the project design. The actors manipulate documents to produce drawings, texts and spread-sheets.

To produce these documents, actors have to take a role inside the organization [FIGURE 1]. These roles are : design architect, expert architect, responsible architect, technical expert, member of project owner (town council), and neighborhood committee member.

We take as project study the design of a square planning. At the beginning of the cooperation the actors should setting up folders and access rights in order to respect the various levels of validation [FIGURE 2]. The access rights are set by creating a new folder for each actors group of the project. This solution does not give a fair representation of the project progress because of the hierarchical organization of folders which reflects rather the project group structure than the relations between actors [FIGURE 3].

Results of the experiment

The project progress illustrates the necessity to define strict exchange rules to maintain the system coherence. These rules mainly concern the files naming and the organization of graphic layers. The experiment shows that it is easy to define a coherent graphic layer organization, but it is more difficult to respect a files naming system. Indeed, we notice the actors relinquish gradually the naming rules to give file names they consider more explicit.

The information structure used in most of the existing groupwares coerces the users into creating copies [FIGURE 3] of files during the validation phases. When an actor wants to make a file visible to an another people, he has to copy this file into an another folder. It produces many copies of a same file what generates many noise for the information retrieval aspect and also incoherence between the different file versions. This point constitutes an important limitation for the use of groupware tools in the building context. Alternative information models exist [Dourish]. Our work is inspired of these approaches, thus we propose a relational model of the data exchange in the projects.

The relational model

Each actor has a specific assignment in a project according to the commitments defined in contracts, quality management plan and domain laws. Each actor's assignment is used during the project planning to define the actor's role during activities. Contrary to the model illustrated in [FIGURE 3] based on the hierarchical structure of the project group, the relational model uses the actors' roles in an activity to determine the relations the actors will have with the documents. These roles could be : author, co-author, advisor, responsible, reader, etc... From these roles we can determine the relations that an actor will have with the activity's documents [TABLE 1].

The access rights are implicitly deduced from "actor/document" relations. For example when an actor has validated a document, it becomes visible for the next actor which will use it according to the relations he has with it. Thus the document remains coherent with the project context, only properties and access rights are dynamically modified. The document location never changes, there is only one copy of any document version.

The definition of the roles and the relations allows the system to coordinate itself during the conception.

Information structure

The [FIGURE 4] represents our relational model structure. In this model we identify the following information types :

- The project, which is planned in activities,
- The activities, where actors generates professional documents,
- The participants (actors) which could be a single person or a group of persons
- The roles own by each actor in an activity,
- The relations between actors and documents which determine the access right on document versions,
- The professional document versions which can be a simple file or a group of document version.

Documents and files

In our model a document is not a simple file. It represents a professional concept which is a deliverable documents of a contract. Most of the time, several files or set of files with a variety of formats compose this professional document. For example, an invitation to tender document could be composed of drawings and texts describing technical specifications.
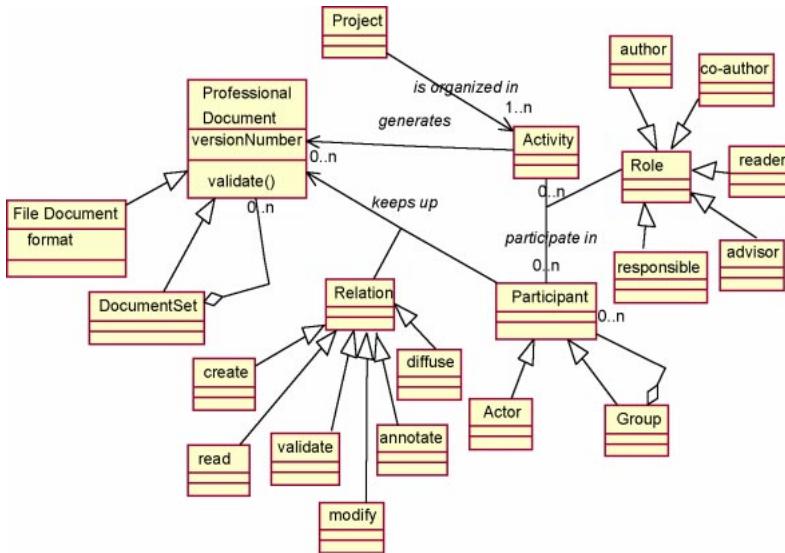
Table 1: Example of roles and relations

Relation Role	Create	Validate	Modify	Diffuse	Annotate	Read
Author	X		X	X	X	X
Co-Author			X	X	X	X
Responsible	X			X	X	X
Advisor					X	X
Reader						X

Figure 4: The relational model.

In our model, each document has a configuration which represents an image of its advancement state. These document configurations give the actors at any time a general vision of the project progress. The configuration management is coupled with the actors' role management in order to attribute automatically the right number of version and revision to documents and files.

Implementation, graph visualization

We represent documents and actors in a relational model preserving the data coherence (configuration management). The model implementation invokes at the same time an aspect of representation and presentation [Tufte E.]. The experiments led on concrete cases allow us to identify some manners to present to the user the information contained in our model. Then we want to propose to the user a graph visualization [Herman] of the project where nodes will be the activities, the actors and the documents and the links will be the roles and the relations. This visualization will give the user the possibility to navigate inside the structure to research some information, to evaluate the project progress or to know the current actors' activity.

Some group awareness favorable to a productive work will be also present in this implementation. It is based on two main characteristics:

- A fair distribution of information among the actors of the project; indeed, the actors keep their autonomies throughout the conception. Thus, the system should inform the actors on new events and documents revisions.
- An actor's activity tracking allows the participants of the project to know "who worked and on which document?"

Conclusion

The contribution of our research in the practices of concurrent engineering is made first of all by the implementation of the following notions :

The vision of relations existing among actors and activities. These relations allows us to describe more finely the dependencies between actors and documents. This relational network is the masterpiece of our model.

The composite documents or professional document that include a variety of files types.

This relational model is combined with a configuration management in order to show a simple expression of the project life cycle.

This model of cooperation seems to be more suitable to the reality of the building trade context.

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