Modelling practices and usages to improve adaptation of groupware-tool services.

Application in the AEC sector

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Abstract. Our approach aims at improving Computer Supported Collaborative Work (CSCW) in the particular context of construction projects. In this context, numerous actors work together, assuming their own role and business tasks, depending on the nature of the project. According to these specificities, services proposed by groupware-tools cannot be generic but have to fit real needs. We propose in this paper a method for 1) analyzing and modeling role-specific business practices and 2) identifying usages of groupware-tool services. The objective is to build an inventory of such practices and usages, based on our model-driven approach.

Keywords*. Model-Driven Engineering; Groupware-oriented services systems; HCI design; Business Practices; Usages*

1. Introduction

In a society where communication modes are in expansion, professionals have more ways for working together, using Information Technologies (IT): sending mails, sharing documents, managing teams… IT services can respond to most of the people's needs regarding their own work in a collaborative context. Each tool has its own functionality and user interface design, which fits more or less the users.

Collaboration, in particular Web-based collaboration and project management systems supported by software tools are a real issue for the construction industry. But in the Architecture, Engineering and Construction (AEC) domain, do the actual technologies really fit the professionals' needs? Indeed, each actor in an AEC project has his own practice and habits. They are related to the role he plays in the project and to the collaborative practices adopted by the project community. That is why designers of IT services should, as a first priority, consider the particular needs of professionals of the construction sector. The following study consists in identifying and understanding these particularities to propose adapted groupware-tool services.

According to specificities of every project and the variety of people who participate, the behaviour of each actor cannot be predicted. However, it is possible to identify and model role-specific practices which appear in an AEC project. In such project, the concept of practice is characterized by the organizational and the operational roles of an actor in a particular situation.

The main hypothesis is that the proposition of groupware-tool services and visualization interfaces must correspond to role-specific usages of business users. Indeed, each actor who uses a groupware does not perform the same usage of the proposed services than another. According to this hypothesis, this study introduces the different concepts which characterize a usage.

The second chapter presents related works about model-driven approaches dealing with business practice analysis conditioning adaptation of technology. The third and fourth chapter introduce the concepts of Collaborative and Individual Practices, through 2 meta-models and a method. The fifth chapter presents a tool to support this method with a graphical edition. In chapter 6, an example illustrates the identification of groupware tools usages from practice concepts. The final chapter concludes this study and introduces future work.

2. Related works on business practices modelling

2.1. Literature review: adaptation of technology to business practices

The understanding of the users, their characteristics, their objectives, their tasks and their environment constitutes an important part in the design process of HCI and IT services. The user-centred design approach, as described in the ISO 13407 norm[1], recommends the participation of future users during all the steps of design processes. However, according to the tight economic context in the AEC sector, professionals have no time to spend in such participation. The challenge is then to interpret their work and anticipate their activity in order to design appropriate solutions. Thus, professionals of the domain should only be implicated for verification and validation steps of design projects.

The following studies deal with the same issue with their own methods and in their own domain. Some of them are applied to the AEC sector, but this review also considers more general approaches.

Nardi (1995) introduces other research works addressing how activity theory benefits studies of HCI. According to him, developers have to think about useful systems and not only usable systems. Activity theory offers a set of perspectives on human activity and a set of concepts for describing it as notions of "context", "situations" and "practices". "Activity theory has its origins in the search for an alternative to the existing basis in behaviourism and psychoanalysis" (see (Wilson, 2006). We also learn in (Wilson, 2006) that Leont'ev (1978) "developed an important distinction […] between activity, actions and operations and relates these terms to motives, goals and the conditions under which the activity is performed".

In the domains of knowledge management, social computing, and virtual communities, Soulier & Lewkowicz (2006) propose a descriptive modelling for the simulation and assistance to business collaborative practices. By integrating physical, social and cognitive aspects they build a group of models based on real-time information gathering. Thus, they describe seven models defined as: the agent model (roles, functions, localizations, personal relations...), the activity model (actors and objects behaviours), the object model (tools, documents...), the context (of activity) model, the temporal model (constraints, preconditions; necessary time...), the knowledge model (activity combination) and finally the communication model (describes actions of communicating). Working on Information Systems design, they use a modelling approach to simulate the collaborative activities in order to propose assistance to these practices.

In the software engineering domain, Constantine (2006) introduced the usage-centered design based on 1) three principal abstract models which guide the process of an adapted design of user interface (role model, task model, and content model) and 2) two surrounded models (the domain model and the operational model). Behind the role model, a user role description characterizes the user: his needs, his interests, his behaviours... To be more precise, a user role is represented by the context in which it is played, the characteristics of its performance, and the criteria that must be reached by the designer to support successful performance of the role. The authors developed some checklists to identify roles and to "help designers think about the central issues and judge what is likely to be most relevant for user interface design". All of this information is finally gathered in a card-based model to create and manage a model “as quickly and painlessly as possible".

Sottet et al., (2005) addresses the issue of plasticity: the capacity of a HCI to adapt itself to a context of usage and respecting some usability criteria. Their work aims at showing that MDE (Model-Driven Engineering) could help to represent and manage several aspects of HCI.

Riedemann and Freitag (2009), usability engineers, developed some techniques and tools for modelling usages. They combine use cases, user stories, and problem scenario techniques, to "describe interaction with the future system along a task model”. Through a tabular notation, use scenarios express the conversational style of user action and system reaction. “Use scenarios are an effective technique for modelling usage based on the concept of tasks”. Their application can be numerous: user documentation, documentation of prototypes, usability and acceptance tests.

According to ((Froese et al. , 2007) cited in (Shen et al. , 2008)), “the most frequently identified issue" for construction industry is "related to collaboration and particularly “Web-based collaboration and project management systems followed by integration of software tools across the project lifecycle."

Considering the AEC sector and in particular sustainable approaches, Arditi et al. (2002) and Pulaski et al. (2006) developed the concept of constructability practices. The goal of their research is "to identify constructability methods that increase inputs from construction professionals during design and construction".

They define which issues arise, when in the project they arise, how they are resolved and including which members.

Sandkuhl (2010) introduced the concept of "information supply pattern" to "capture organizational knowledge about best practices". This work is derived from industrial requirements and is illustrated by an application to the automotive industries. In few words, each identified pattern is defined by: a name, an organisational context, a problem, a conceptual solution and his effects, and finally supply actions for getting the needed information.

2.2. Previous works on cooperative context

Previous works have been dedicated to the representation of the context of a building project (Kubicki et al., 2006). Such cooperative context comprises different elements in relationship. The objective is "the description of the meaning of a project and then the proposition of adapted tools and visualisation modes included in a cooperation platform". The meta-model of this cooperative context is composed of:

- Actor: from a collaborative context (e.g. construction project) to another, actors and their relationships change. An actor can be completely integrated in the cooperation context or can be external but in any case he is commonly identified by the role he plays in the project (organizational role).
- Activity: each project can be divided into different phases during which business tasks are performed at precise moments of the process. The task is the lower level in dividing the activity and can even correspond to single actions not necessarily repeated during the project.
- Artefact: this concept gathers both documents (information in different types, existing during the project) and objects (virtual or physical product, as the building is designed and built). They both can be defined by a type, an author and a context of production among the activity concepts.

Depending on the project, each class of this meta-model can be instantiated at a model level (Kubicki et al. 2006).

2.3. Introduction to practices

All the related works (2.1) show several concepts to describe activities, roles, practices and contexts in several professional environments. The previous works (2.2) about cooperative context particularly deal with the different elements involved in a construction project. A meta-model has been developed based on these concepts. However, these concepts can be used in a new approach. The objective is to characterize the nature of the relations between actors, artefacts and activities. The following part introduces new meta-models intended for characterizing business practices in the collaborative context of construction projects.

3. Identification of collaborative practices

In the collaborative context of a project, Collaborative Practices (CP) are defined as the behaviours of groups of actors working together in various organizational situations according to business needs. The Collaborative Practice Meta-Model (CPMM) characterizes a CP with the concepts defined above by the cooperative context. As illustrated in figure 1, a CP is defined by a name and a business need, involves in general more than one actor, one artefact and refers to at least one context of activity.

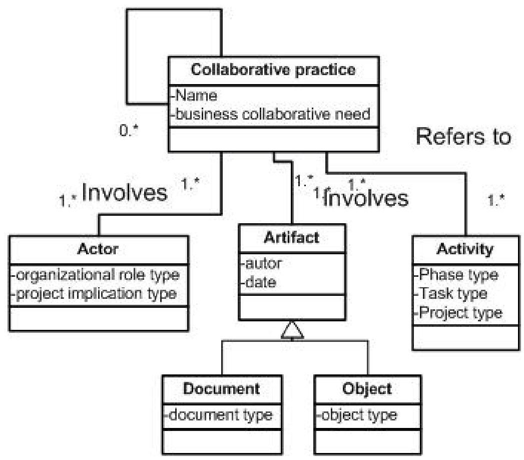

Figure 1. The Collaborative Practice Meta-Model (CPMM)

An overview of the entire life-cycle of an AEC project allows identifying an amount of generic practices. The study of sustainable approaches and ecological guidelines like HQE[2], BREEAM[3], MINERGIE[4] and DGNB[5] was useful because of the accurate goals to reach in such project. This method had the advantage to give:

- A global overview of a project process
- A precise description of the role played by the actors (or the role they should play)
- A precise description of the objectives to reach and the needs.

From this analysis, we identified five general objectives to reach by the actors of an AEC project. They generally collaborate to:

1. Ensure the quality of the building: it includes both conceptual and technical choices. This objective can refer to focused requirements like limited impact on environment with reduction of energy wasting, use of green materials…
2. Ensure the user's comfort: this objective also concerns conceptual and technical choices but focuses on thermal, acoustical or visual aspects. It also includes quality in terms of security or accessibility.
3. Ensure the economical efficiency: within their choices, actors must control

the budget but also ensure the flexibility and adaptability of the building.

4. Ensure the quality of the site: according to localisation and linked risks, environment quality, connexions to transports, services, infrastructures…
5. Ensure the socio-cultural quality of the project: this objective concerns the impact of the project on population, administrations…

Through a brainstorming with professionals, we have been able to identify what they usually perform to achieve these objectives. Eleven generic CPs should be observed in most of construction projects situations: (CP1) site choice and assessment, (CP2) designer determination, (CP3) objectives determination, (CP4) budget determination, (CP5) design and reporting, (CP6) construction enterprises (contractors) determination, (CP7) design assessment and reporting, (CP8) meetings organization and reporting, (CP9) execution preparation and management, (CP10) execution assessment, (CP11) users' awareness.

These CPs could be characterized by instantiating the CPMM.

According to our hypothesis each actor or project role, involved in such Collaborative Practices, performs related operations using and producing information. These role-specific practices are named "Individual Practices".

The next chapter proposes a model-driven description of the concept of individual practice (figure 2).

4. Modelling Individual Practices

4.1. Concepts of the Practice Meta-model

To define Individual Practices (IP), some new concepts (figure 1) were introduced from the cooperative context described in 2.2.

An Individual Practice is identified by a name and a goal. It is defined in one or several operations (e.g. to share, to validate, to look for, to ask for, to be advertised, to contact...). Each operation is performed by an actor but can also "refer to" other actors (e.g. the architect contacts the engineer). Actors have - more than their business role - a business implication which determines if they are internal (like architects or contractors) or external (like administrations or experts). Then, an operation can target documents or objects (e.g. to share / look for a precise document of someone). Some context precisions bring information about conditions of practice operation: the context o activity, the temporal and the physical context.

The model finally contains a class for the Collaborative Practice from which is derived the individual practice (see chapter 3). IPs are linked together, considering that one operation often generates another in the same or in another CP.

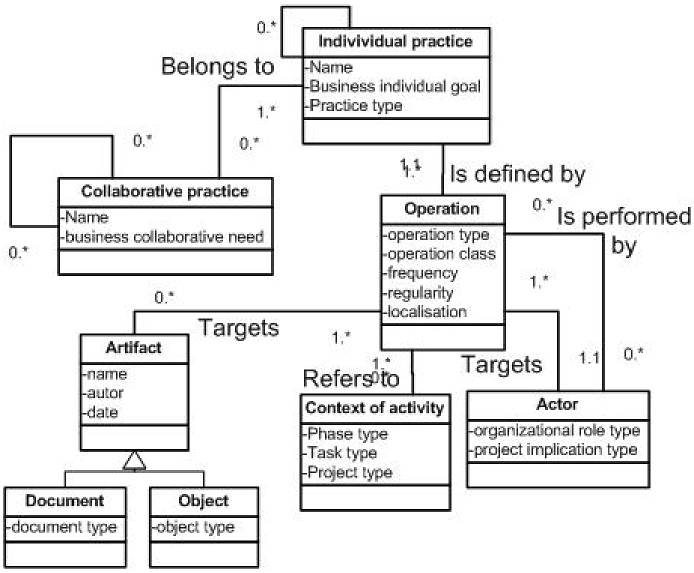

Figure 2. The Individual Practice Meta-Model (IPMM)

4.2. Toward a method to define Individual Practice from the IPMM

Using the concepts developed in our model (figure 2), individual practices are identified through a method in five steps (figure 3):

First step: which practices are identified? We define here both the collaborative practice (within the list of eleven) and the individual practice (giving a name). The related needs and goals are explained in a few words.

Second step: who performs the practice? The main characteristic of an Individual Practice is its "role-specific" property. This role attributed to an actor is closely related to the collaborative domain (e.g. in construction projects: contractors, designers, coordinators, experts…).

Third step: what is the effect of the practice? We define in this step the operation(s) performed in the practice Active operations (e.g. to share, to contact) are distinguished from passive operations (e.g. to be informed).

Fourth step: what is the information referred to? For each operation, the artefacts and/or the actors that they target are defined. For the artefacts, it is necessary to precise their author and from which business tasks and phases they are issued. For the author, the properties identified are the same as in the second step (role and implication). We also try to quantify the volume of manipulated information.

Final step: in which context the practice is performed? This step consists in defining activity context, temporal context and physical context. The activity context precise which type of project, phase and tasks are concerned by the practice. The temporal context attributes a frequency and/or regularity to the practice while the physical context attributes a localisation.

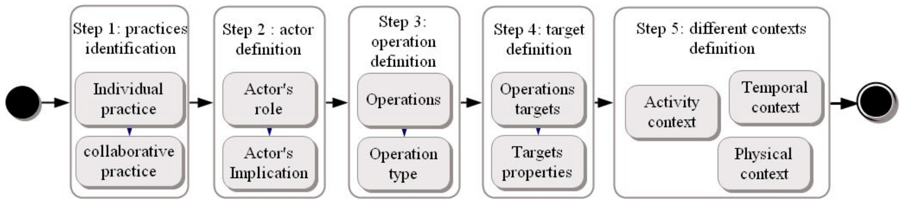

Figure 3. The practice definition method in 5 steps

5. A tool to support the method

This chapter illustrates the definition of a specific Individual Practice with the method described above. A graphical editor to support this method is presented in the second part.

5.1. Building an Individual Practice with the method: an example

The Collaborative Practice "CP7: design assessment and reporting", consists in submitting design documents by the designer to an advised expert. In several contexts the owner could also take this responsibility. This assessment is then formalized by one or more reports. According to the results, the documents will be executed or modified.

From this description of the CP7, numerous individual practices for each actor could be identified. Some examples of architects-related individual practices are given below:

- Searching an advised expert
- Submitting design documents for assessment
- Staying informed of results before going on with execution

We will use our method to define one of these Individual Practices which composes the CP7: the IP "Submitting design documents for assessment". In the first place, a table was created to represent this definition (table 1).

5.2. A tool to support a graphical representation of practices

The definition of such IP with our method seems to be time consuming and fastidious. Even though, this practice is quite "simple" with only two operations and targets, and one execution context.

However, these IP are characterized by recurrent concepts defined in a Meta-model (IPMM). This is why we implemented this Meta-Model in a graphical editor to build and represent them easily and clearly. This editor is developed with the Eclipse environment and particularly the GMF framework (Graphical Modelling Framework). Indeed, the GMF Tooling project provides a model-driven approach to generating graphical editors in Eclipse. The tool illustrated in figure 4 is still in an early stage in development.

	Practice building process	
Method Steps	**Meta-model of Individual Practices**	**Model of an Individual Practice**
Step 1: Practice identification	Name <individual practice>	Submitting design documents for assessment
	Goal <individual practice>	To obtain from an advised expert, an assessment of the conception before the execution
	Name of the <collaborative practice>	PC7 : design assessment and reporting
Step 2: Actor definition	Organizationnal role <actor>	Designer
	Project implication <actor>	Internal
Step 3.1: Operation definition	Operation 1 type <operation>	To share
	Operation 1 class <operation>	Active
Step 3.2: Operation definition	Operation 2 type <operation>	To ask for validation
	Operation 2 class <operation>	Active
Step 4.1: Target definition	Document/object type <document/object>	Plans
	Author <artifact>	Designer
	Phase of production <activity context>	Conception phase
	Task of production <activity context>	Design Task
Step 4.2: Target definition	Role <actor>	Expert
	Project implication <actor>	External
Step 5: Contexts definition	Phase <activity context>	conception phase
	Task <activity context>	coordination task
	Frequency <operation>	Randomly
	Regularity <temporal context>	Not often
	Localisation <physical context>	At office
	Qualitative caracteristic of information considered <information quantity>	A lot of information to deal with

Table 1. Definition of the IP "Submitting design documents for assessment" with a table-based representation

This editor consists in instantiating the IPMM for all the Individual Practices that we will identify. A set of icons represents several actors, operations and artefacts. It is possible to dispose them by a simple drag and drop and link them together. In the example illustrated in figure 4, the IP is performed by the designer and is composed of 2 operations (to share and to ask for validation). These operations concern CAD documents and the expert who is required for the assessment. Each of these elements can be edited by the properties defined in the IPMM. This edition consists in choosing properties within several lists.

This editor has the advantage to propose a useful and faster method to build IP with the concepts of the IPMM. Moreover, all the information which characterizes IP can be extracted in xml data. The next section introduces how to define which usage of several tools could be performed to support this IP.

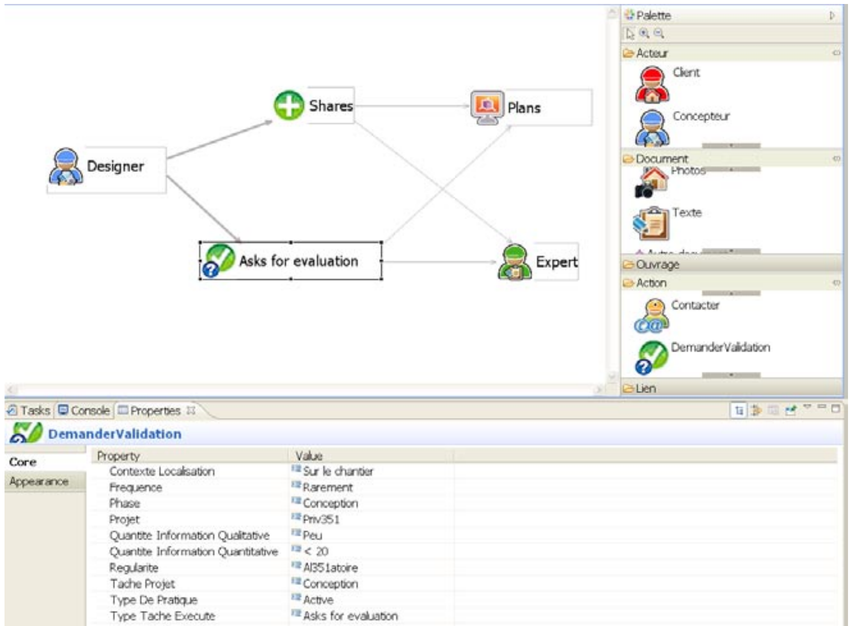

Figure 4. Definition of the IP "Submitting design documents for assessment, with a graphical editor

6. From practices to usages: a first approach

A usage is defined by an instrumental nature: it confronts actors to specific tools in order to fit with their business needs. For example, an architect designing plans in the design phase may perform specific usages of CAD tools. Considering document sharing, several usages are adopted.

6.1. Comparison of possible usages for one IP

The Individual Practice "Submitting design documents for assessment" described above could be performed in different ways. Several usages (or groups of usages) can support this practice:

1. Printing the documents and sending them by mail: this is a "traditional" usage. The designer sends his documents and a notice to explain what he expects. He could eventually use the phone to contact his addressee. These usages refer to mail and phone. They take time and are not really secure.
2. Sending an e-mail and joining the document to evaluate: this is a common usage. It is faster and more secure. But the quantity of shared information is limited and there is no traceability of this information. Then, there is always the risk of lost information.
3. Sharing documents with a groupware and asking for evaluation: Professionals begin to adopt usages related to groupware. Such tools offer

to share and to manage information, and to facilitate the collaboration between different actors. But, most of them are generic and do not propose adapted services like an "evaluation service". However, there are a lot of possibilities to improve usages of groupware tools developing more new services.

With these few examples, we observe that actual usages show their limits when adopted for this specific IP. But, with the knowledge that we obtained from the practice characterization, we should be able to improve them.

6.2. Toward a characterization of the usages of a groupware-tool

As we described it, a usage is related to a tool or a group of tools. A team chooses to perform a "Collaborative Usage" of a specific tool (or group of tools). For example, they can share documents using a groupware.

Then, each actor will perform his own "Individual Usages" of the tool. These Individual Usages (IU) are directly conditioned by his Individual Practices. To illustrate this matching between IP and IU, let us focus on the IP "Submitting design documents for assessment" which is a designer-specific practice.

- Each actor with his organizational role is identified as one particular user of a tool so we will not propose the same usages of a groupware to each actor.
- The operations generate a need of specific services composed of several interactions. The IP "Submitting design documents for assessment" is composed of 2 operations: to share and to ask for evaluation. That is why the adapted usage must propose corresponding services for the given situation: a sharing service (proposed by all groupware) and an evaluation service (that has to be developed).
- The targets of the operations (actors/document/object) represent the numerical information taken into account by the groupware tool. Depending on the situation, this information can be more or less numerous and have different properties to be visualized during the use of the groupware tool services (name, author, related dates).
- When we define the different context of Individual Practices execution, we identify elements to precise the usages requirements. Indeed, it is important to identify when and where a usage is performed. The context of activity brings information about the business process in which is involved the usage, while temporal context inform about more general data (frequency, regularity). For example, we know that the IP "Submitting design documents for assessment" is performed at the end of the design phase but not often. The physical context (localisation) of a practice gives information about the device which will support the usage. Indeed, the mobility of some professionals involve that they may use different devices to accomplish their tasks. In our example, there is no real need to adapt the usage of such services with mobile devices.

We will have to consider more practices to analyse which usages are adapted and how we could improve their characterization.

7. Conclusion and prospects

During this study, a characterization of business practices in particular collaborative situations of construction projects was proposed. We identified both Collaborative and Individual Practices (CP and IP) and characterized them by two Meta-Models (CPMM and IPMM). Collaborative Practices can generally be defined as "more than one actor working together with common needs and objectives". Then, Individual Practices definitions focus on the work of each actor, involved in such CP, and the role they play in a particular context. Several meetings with professionals will be organized to understand how these practices can vary depending on the situation.

A method was proposed to define such Individual Practices in five steps. In front of the difficulty to describe these practices with all their properties, we proposed an editor based on a graphical representation of the concepts of the IPMM and their relations.

The second half of the paper focused on the identification of adapted usages of groupware-tool services. Indeed, we assume that such tools must be developed with a sufficient knowledge of professionals needs (e.g. professionals of the construction sector). Then, this characterization of usages will be useful to determinate properties of the services that we will propose to support it.

Parallel works aim at characterizing visualization mode to identify possible adaptation to related usages. Moreover, we are always investigating the meta-models of Practices and Usages.

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Notes

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[2] http://assohqe.org/hqe/

[3] http://www.breeam.org/

[4] http://www.minergie.com/home_en.html

[5] http://www.dgnb.de/_en/