Towards an Extended Enterprise Memory in Textile industry

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Abstract

The This paper presents our work to define an Extended Enterprise Memory which is an explicit representation of knowledge for cooperative activity. This work is relevant from cooperative engineering which is Knowledge Engineering process in the context of cooperative activities meaning collective activities which are not yet entirely formalized

1 Introduction

Our main objective in this paper, is to analyze cooperation between companies (what we call extended enterprise cooperation activity) in order to capitalize on related knowledge as an Extended Enterprise Memory (EEM). Such analysis is relevant to Cooperation Engineering (see. §4) which is a Knowledge Engineering process in the context of cooperative activities meaning collective activities which are not yet entirely formalized. It intervenes as an essential step for the operation of a Knowledge Management process adapted to the development of extended enterprises and to the building of Information System elements which facilitate communication, coordination and collective problem solving (mailing, discussion forum, EDI, workflow, GED, semi-structured databases, etc.).

We begin by presenting the current problematic of extended enterprise and the reasons for which Knowledge Management problematic is particularly delicate. Then we define the notion of cooperative activity and Cooperation Engineering, introducing the notion of Extended Enterprise memory (EEM) as an explicit representation of inter-company cooperative activity. Finally, we present the area of textile industry in which these solutions will be tested.

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2 Extended enterprise

To respond to an economic and competitive environment which is becoming more and more complex, as well as to the globalization of markets, firms opt more frequently for alliances and partnerships, developing new net-working forms. The emergence of the concept of extended enterprise or networked companies is the result of the hope of some firms to form alliances with others, after careful selection and to set up long-term and valuable exchange relationships, so as to lighten infra-structures. The network keeps going thanks to the competence that each brings to a common project participation which does not affect their legal independence [Pac93].

In this context the concept appears in the form of firms showing capitalistic and legal independence and capable of specializing in one task in the same value chain ([Jar88]; [Pow90]). When choosing multiple alliances, these firms favor contractual growth rather than patrimonial growth. In fact, they aim at more flexibility and reactivity with a lighter structure, and the preservation of their independence and opportunities, to evolve constantly on the market.

According to many authors, the effectiveness of the network structure is highly dependent on the good use of IT such as EDI, workflow and Internet which facilitate the coordination of interdependence between the different units of the network. Network strategies rely, on the one hand, on all the techniques linked to merchandise flow processing, and on the other hand, on Information Systems which allow an efficient coordination of operations between partners all along the added value line of a product or a service. Such techniques and Information Systems being built on IT, represent, according to Lorino [Lor89], "a strategic factor for the development and the success of companies". These tools favor the mastery of material flow and techniques via information flow. They make professional links more efficient by allowing collective learning and knowledge transfer ([Ali93]; [Spi95]).

The importance of good Collective Knowledge Management will be examined now, for networked company functioning, and for the specification of Information Systems in inter-company cooperation.

3 Knowledge Management plays an enormous role within the extended enterprise

As many authors have explained ([Ste93]; [Erm96]; [Gru96], the pressure of technical and organizational innovations, new management modes (project management), voluntary or enforced staff mobility (transfers, redundancies, retirements) explain why Knowledge Management has become such a major preoccupation in numerous organizations. Here it is seen from *Knowledge Systems Management*'s point of view; which means focusing on the artifact construction problematic facilitating the recall and transmission of and access to the knowledge, but also as a preliminary step for the construction of Information Systems for cooperation (see. infra). J.L. Ermine quotes the CEA quality handbook which defines Knowledge Management, as seen before, as enabling:
-" the collection of knowledge and know-how on more easily accessible media,
- their transmission in real time inside the CEA and later to their successors,
- the tracking of certain activities or actions about which the CEA could be asked in the future" (Quality handbook of CEA, 1996, p. 14, quoted by Ermine 1996 p. 16).

Knowledge Systems Management plays an enormous role within large firms, and even more so in the firms integrated in the network (i.e. extended enterprise). Even when firms are centered on their own know-how, they are extremely dependent on their partners as regards adjusting their production and in their innovation processes. These companies must always be up-to-date with their partners' evolution to be better adapted to and be able to anticipate new needs and future constraints.
According to Grundstein [Gru96] Knowledge Management problematic can be tackled from four angles:
- locating the crucial knowledge (identification, location, characterization),
- its preservation (modeling, formalization, conservation),
- its evaluation (access, diffusion, operation, combination, creation),
- and its evolution (updating, enrichment).

The present research context focuses on the preservation and the evaluation stages. Preservation involves the implementation of modeling processes of partly tacit knowledge. Evaluation involves the elaboration of software tools which allow access and distribution of modeled knowledge either in the extended enterprise, or within the specifications of its Information System. Therefore, this research is original in two ways:
- The knowledge modeling concerns not only problem-solving knowledge but also knowledge allowing cooperation between partners.
- The knowledge distribution and operating tools, such as Information Systems whose modeling enables their specification, are intended not for use within the firm (intra-organizational use) but as supports for the relationships between different firms integrated in the network for a period of time however limited.

4 The cooperation between firms makes knowledge management critical

The actors co-operate when they exchange resources when taking part in a common task. The cooperation can be vertical (either between producer and provider or even in the fields of production and marketing) or horizontal (between companies in a same sector). The need for cooperation comes from the division of labor, but is more complex than a simple co-ordination of tasks and activities between actors (a primarily economic view). The construction of a common project requires either close representations and close interests [Cro77] or equivalent but non identical ones [Wei79]. The cognitive dimension of cooperation between various actors, namely the exchange and construction of knowledge and of common and shared experiments, is essential. One of the essential concerns of cooperation engineering is to manage knowledge.

The literature shows that a situation of cooperation is built or emerges around tools facilitating the structuring between actors and the information exchange [Rau95].

The main question is to evaluate the characteristics of the tools suitable for use as an argumentation system within a cooperation framework.

The study of cooperation processes requires the following theoretical principles and definitions.

5 Cooperation engineering

For K. Schmidt cooperative work "emerges when multiple actors, engaged in the realization of a common task, are mutually dependent to their work and must coordinate and gather their individual production to be able to do the task which is confided" [Sch94].

For this author, cooperative work denotes exclusively collective work on a common object which corresponds to a principal collective goal. The need to coordinate such cooperative work generates different, specific work that Schmidt calls Articulation Work and which "is constituted of the need to restrain the distributed nature of complexly interdependent activities" [Sch96].

We have not adopted the same definition of cooperative work as it seems, to us, to be a little restrictive. In accordance with Intellectual Transactions Theory [Zac99] we consider that cooperative activities correspond to collective activities in which "cognitive interdependence" between actors is effective, which means that it has not been standardized (we suggest this definition of "cooperation": there is cooperation between actors when the cooperative activity occurs in a context of cognitive inter-dependence, the actors being obliged to commit

themselves to intellectual transactions to reduce this interdependence. The cooperation concept is applied in the context of organized cooperative activities (as opposed to mass behavior phenomenon) in which actors are " structurally independent"). According to this theory, articulation work is included in cooperative work because the existence of the articulation activities is essential in order to define cooperation.

A cooperative activity, whether centralized or distributed, requires the definition of an objective as common to both agents engaged in this activity to obtain the best performance. Its execution presupposes the existence, as a shared resource, of an ensemble of knowledge and in turn generates experience. Obviously, relationships between agents have a big influence on cooperative activity and especially on problem solving.

One of the essential concerns of cooperation engineering is knowledge management relating to a cooperative activity. It enable the extraction of knowledge from experience. There are two main stages:
- modeling of experience which implies formalization of knowledge starting from experience,
- evaluation which relates to effective and efficient re-use of the experience transformed into knowledge.

We define an extended enterprise memory as the result of experience modeling of inter-company cooperative activities. Because this memory enables tracking of shared knowledge during these activities, it facilitates collective training.

A corporate memory is defined thus " the explicit and persistent representation of the knowledge of an organization " [Van96] or as " the whole of the collective data and knowledge resources of a company " [Pra96]. Thus, the memory makes it possible " to preserve, in order to re-use the reasoning, the behavior and knowledge, even in their contradictions and in all their variety "[Pom96].

By analogy, we define the Extended Enterprise Memory (EEM) as the explicit and persistent representation of the collective knowledge of the extended enterprise.
In this definition, we stress the fact that the EEM is the result of modeling of the cooperation experience. This memory makes it possible to memorize knowledge shared during a cooperative activity. It allows learning from situations of cooperation between partners.

The EEM consists of two types of knowledge:
- knowledge coming from the information system of each partner in the extended enterprise and forming an integral part of its own inheritance of knowledge. The question is up to what point to put this knowledge in EEM so that the shared knowledge does not weaken the position of a partner in the extended enterprise (exogenous knowledge).
- knowledge resulting from the cooperation between partners (endogenous knowledge), emerging in a context of not entirely formalized cooperative activities [Bou00].

According to its architecture, the EEM can enable :
- the memorization of some useful knowledge made known to some companies by the others thus facilitating their working relationships,
- the gathering of knowledge resulting from cooperative work binding the partners and the memorization processes in order to re-use them at a convenient time,
- innovation while being informed of what the others are doing in order to anticipate the needs and to reduce the constraints.

In the crucial knowledge of a network of firms, we have created three categories :
- **private and confidential** knowledge. This knowledge being internal to and part of the strategy of the company must not be revealed outside. It is to a great extent registered in the information system of each partner.
- **private but shareable** knowledge within the extended enterprise to which the company belongs and which is the subject of our research. This knowledge is partly registered in the elements of the information system allowing the cooperation (EDI system , electronic mail, extranet...) and cooperation engineering aims at facilitating its clarification.
- **public** knowledge which may accessed, for example, in the partners external communication Web sites.
Capitalizing cooperative knowledge consists essentially in the structure and memorization of common objectives, cooperation contexts, the agents' coordination and communication, relationships and problem solving.

The following part introduces a methodological approach which enables identification and modeling of cooperation knowledge.

6 MCSC: Cooperative information Systems Design Method

The MCSC (Méthode de conception des Systèmes d'information Coopératifs) approach is a methodological framework which aims to guide the design of intra- and inter-companies cooperation mechanisms. It aims, initially, to model cooperative activities and to specify data-processing solutions adapted to the needs and (the) constraints of cooperation. Thus, its objective is to capitalize on the knowledge generated by this cooperation. In our research this approach is applied within the framework of the extended enterprise.

In accordance with Alquier [Alq98], our approach declines the notion of IS differently according to a dimension called spatial by this author who distinguishes between individual, departmental or collective ISs. For Alquier, at the collective level, ISs are called "cooperative", and include all the functionality coming under GroupWare. Relying on the MadeIn'Coop Method [Zac96], we have refined this notion of Cooperative ISs by introducing three new points of view about ISs,

according to the roles which they play in the cooperation processes:
- A **communication IS** which supplies media, facilitating synchronous or asynchronous, face to face or distance dialogs between the actors (for example mailing, discussion forums, videoconferences, etc.).
- A **coordination IS** which supplies media, facilitating coordination between the actors, relying on the concepts of roles, activities, tasks, responsibilities, means, etc. (for example EDI, workflow, etc.).
- A **collective problem-solving IS** which supplies media, facilitating collaboration between actors working on a common task, relying on problem models and argumentation techniques, etc. (for example knowledge systems).

Of course, since the use of the artifacts determines their status, the same computing artifact could take part in all three ISs according to the way it is used in the organization. Complex computing environments can also offer different tools at the same time supplying these different functionalities. Finally, certain tools may associate two functionalities as for example a complex workflow, combining the cooperative documentary support (collective problem-solving) with the collective validation processes support (co-ordination).
We have also introduced a point of view close to Alquier's spatial dimension which identifies three levels of cooperative ISs :
- The **small group** level which corresponds to a project or recurrent processes which involve a limited number of actors who have close knowledge of each other;
- The **organization or extended group** level which involves a number of actors such that deep mutual knowledge is impossible;
- The **inter-company** level which joins groups of actors (small or extended groups) belonging to the different partners of the extended enterprise and which is the subject of our research.

To study these different activity levels and to specify the ISs responding to their needs, MCSC identifies two levels of modeling which correspond to a progress in conceptualization, and in which different techniques are used as regards IS design methods and cooperation engineering:
- A **macro** level where company processes are modeled 'trade by trade' in an intra- and inter-company context. At this generic modeling level the main interests are in the description of the activities or business, the actors who take part in it, their relative positions and their relations in their specific context.
- A **micro** level focusing on a particular process and its actors and artifacts particularly the cooperative activities and artifacts that they use as regards these three models (communication, co-ordination, collective problem-solving).

To build a micro model, we have tried to set up the following stages:
- focus on a particular activity and its detailed description in terms of objectives, tasks, sub-tasks, resources, constraints, etc (*the model*),
- specification and development of a software tool for cooperation which will facilitate the course of this cooperative activity. Such tools concern the NTIC and more particularly GroupWare tools such as discussion forums, workflow, etc (*to implement the model in a tool*),
- installation of the tool and observation of its use in context over a certain period of time. We have integrated sociological and ergonomic dimensions into these observations to facilitate the evolution of the model (*experimentation in situation*),
- enhancement of the model by dynamic capitalization of knowledge generated by inter-company cooperation and their modeling with feedback through the EEM (contextualized restitution). (*evolution of the model*).

7 Experimentation in the textile industry

To answer the research questions raised (coherence of knowledge systems, inter-operating ISs, adjustment of levels of confidentiality and sharing of knowledge, MCSC probation, etc.), we have used a field of application provided by the textile industry in a regional environment.
In this industrial field, the extended enterprise corresponds to group of networked specialized companies (mill owner, knitter, dyer, clothing manufacturer…) whose aim is to manufacture a range of products together, at a lower price, by reducing time and investment. IT can be a factor that helps to reduce time in information exchange, and consequently the manufacturing time, while ensuring better quality. But cooperation ISs will be effectively introduced only if all the actors are willing to share and to formalize knowledge.

Although the textile industry is a difficult ground for experimentation it is extremely suitable for the following reasons:
- It is at risk internationally because the labor costs are higher than in the developing countries. It is generally considered that more efficient networking, would be a sine qua non survival condition, as illustrated by the American experience which shows the importance of IT for the re-location of some textile production activities [Abé98];
- In this industry knowledge as well as inter-company cooperation styles are both complex and informal. Implementation of effective cooperative ISs will most probably involve developing a new stage in common knowledge management.

7.1 Description of the field

The textile industry (in the regional context of the "Champagne Ardenne, Aube department") is composed of two sectors : **clothing** (with as main actors, distributors or collectors playing the role of the donors in the industry) and **textile** (knitters and dyers and clothing manufacturers play the role of order takers or subcontractors). The Textile industry we have studied, is specialized in the knitted fabric technique with companies such as

"Devanlay (Lacoste, etc.)", "Doré-Doré (DD)" or "Petit Bateau". The role of the donors varies considerably according to the integration degree of these actors in the industry. The donor position has been constituted starting from the trade of distributor (e.g."Kiabi".) or from the trade of clothing manufacturer (e.g "Devanlay".).

The situation of this industry is very tricky. The donors impose on their subcontractors a hard logic of cost and "manufacture-delivery" quality. This cost logic explains why the donors relocate all or most of the clothing fabrication activity. Consequently the industrialists relocate the upstream activities of the clothing making (knitting and dyeing), more and more, obviously to reduce their costs but also in order to organize the complete production of a textile article in one place. Within a micro and macro socio-economic context, the subcontractors are short on capital and usually small-sized firms (20 people on average), which together with a lack of any marked spirit of co-operation are the main reasons for the problems of the local subcontractors which prevent them from taking up the challenge imposed by international competition.

However some ways of enhancing the textile industry have been studied, around the following ideas :
- product innovation (use of special fabrics for some sectors such as medicine, automobile industry)
- process innovation (better co-ordination, intra or inter company, to provide a faster service and/or better quality).

These changes require new co-operative practices, so three types can be considered :
- product innovation
- coordination of an aggregate offer
- cooperation in capacity.

Knowledge and information exchange in these three areas of cooperation has become essential. This reinforces our original hypothesis: modeling cooperative information systems and offering information and knowledge management tools, such as extended enterprise memory as a tool for cooperation should provide satisfactory choices and optimize transactions between the actors.

7.2 Extended enterprise in the textile industry and memory

The following co-operation example explains how the EEM can be used as a support for cooperation aid for:
- collective training
- knowledge transfer
- collective decision-making (argumentation, constraints, planning: calculation of manufacturing requirements and production flow)

Let us imagine the following cooperation example: once an invitation to tender is launched by a donor, a set of subcontractor actors will be progressively constituted to answer it. The constitution of the set results from the choice of certain actors (knitters or dyers) to favor certain other knitters or dyers, so as to make an aggregate offer to the donors. This choice is based on information and presupposes the actors being able to cooperate. The EEM plays a role in the emergence of this working group in the following way:
- On the one hand, the EEM provides subcontractors with information on the competences of the partners. The subcontractors have to choose: information on machine capacity, more or less qualified workforce, threads usually worked, financial standing or even capacity of reactivity. Since the knowledge, related to the partner's / partners' inventory, or to its / their workload already in progress, is available in the EEM, it becomes easier and faster to establish coordinated planning of work between several subcontractors to answer the invitation to tender. In the same way, the EEM may contain a set of nomenclatures or codes related to manufacturing process stages, or related to knitwear colors, etc., so as to facilitate drafting and work order exchange between subcontractors, containing this type of technical data. This varied information is especially **substantive** knowledge.
- On the other hand, subcontractors will also access information via the EEM about how past relationships between some actors have functioned. This EEM could contain the set of orders / purchases required by donors. This could include details of subcontractors had taken up the order as well as its conditions, (exceeding delay times, call for subcontracting or not...). This varied information is more **procedural** knowledge.

Both kinds of knowledge are important since they will enable actors to choose whom to work with. However, they should not have " to negotiate " the access to this information when that relation is established. All those concerned should have simplified and precise access to information via the EEM. This access to information is also very rapid, an essential condition in such a competitive environment, where in fact the most reactive and the most flexible companies may hope to gain market share.

For example, let us illustrate two types of invitation to tender:
- According to a process directed or "channeled" by an actor (knitter or dyer) ; this actor would take the role of coordinator in the constitution of the corporate network; he would be informed of the invitation to tender and would look for other partners to answer it. A coordinator in the extended enterprise could be responsible for, launching, for example, the production of a new textile collection, he could send out a call to all the partners to design this collection. Each one of them would be part of the value added at his stage of the chain of production :
    - the raw material supplier would suggest the most suitable thread for the collection,
    - the mill owner would suggest a type of spinning, or the knitter a style of knitting,
    - the dyer would suggest a range of colors and a certain number of processes,

- the printer would suggest a certain number of patterns and designs,
- and finally the clothing manufacturer would suggest a certain number of models / styles.

- Using EEM: According to a more emergent, self-regulated process; the invitation to tender would be proposed (via a server or a centralizing organization for example) to various actors who would .mutually compare and adjust their work capacities to tender together.

Through this example, it seems clear that knowledge management amongst partners within an extended textile enterprise can be ensured via an EEM (according to our initial hypothesis) which can provide the following advantages:
- a better mutual knowledge (kinds of trades practiced, available resources, and so on), enabling anticipation of requirements,
- the use of knowledge about previous situations of cooperation, providing a decision-making aid by enabling the estimation of production times and costs, a better allocation of resources and supplies and a better management of competences within the network.

The use of this cooperation support should enable:
- improved cooperation between partners as time goes on,
- improved product quality,
- innovation in all the stages of the production chain,
- reduced manufacturing times and investments,
- reduced cost prices for textile goods, making them more competitive on the market,
- motivation for every actor so that they give the best of themselves in terms of competence and involvement. Each thus becomes a factor of innovation instead of a simple subcontractor in the field.

The remaining question is about EEM construction, the choice of exogenous knowledge to be preserved as well as the capacity to formalize endogenous knowledge (resulting from work processes already operated). This also can reveal the question of the nature of the "strategic information" which can be shared by partners within an extended enterprise and if a partner can leave or enter this network, which is largely informal, at any time. This last point is of course significant but it will not be clarified in this paper.

7.3 MCSC Application :current work and perspectives

We started to study the processes of this industry, following the stages of our approach:
1- the **macro level** : modeling the operating modes and the decision-making processes within the textile industry and categorizing the business, the actors and their relationships. Here is an example of models to describe a " study" in the textile industry.

2- the **micro level** :
We focused on the cooperation between a knitter and a dyer and identified different scenarios of cooperative work as compared to 'normal' knitters' activity.
We specified and developed a tool (WebEDI) for electronic data interchange based on Internet which allows these two partners to exchange commercial and technical data between their information systems (form for handing-over natural products, form for dyeing handing-over, delivery form, etc.) within the framework of the sale of « knitted fabric by the meter » carried out by the knitter.
We are currently going to develop this tool in two directions: from the point of view of coordination, to specify a skeletal tool for multi-partner cooperative workflow adapted to the use of other exchange documents, from the point of view of problem-solving, to extend the functionality of the memory tool to adapt it to the storage and handling of knowledge.
We are still modeling other sectors of activity and other cooperation processes in the industry in particular the making up and distribution. At the same time, we are improving the previous models.
We are currently planning the observation of the uses of this tool to facilitate the cooperation in two tasks: knitting and dyeing.
The results of this observation will enable us to capitalize on knowledge, specific to this type of coordination, which will enable us to define their functionality allowing their further operation.
We are studying the knowledge modeling methods (such as MKSM, KADS, REX, etc.) to adapt one of them for EEM Knowledge capitalization.
At the same time, we are taking part in the development of a questionnaire with the managers and sociologists of the Tech-CICO laboratory, to identify shareable knowledge at the level of an extended enterprise.
We are also collaborating with the linguists of the Tech-CICO laboratory, particularly in the modeling of the communication IS mentioned.

8 Conclusion

IT technologies are good technical supports for workgroup. But, this type of tools does not represent well efficient help for cooperative activities. We regret a formalization of subjacent process.

As answer to this missing, we propose to analyze and model inter-company cooperative activity by distinguishing its dimensions. We base our analysis as well as on a theoretical study and practical observation of an activity in textile extended enterprise.

Our main objective is to develop techniques, based on the models so defined, that support an inter-company cooperative activity. For instance, the extended enterprise memory (EEM) forms a good example of this type of techniques. We offer with this modeling macro and micro vision of cooperation process.

Such modeling is guided by cooperation engineering that has, as its principal objective, knowledge management of a complex cooperative activity which requires articulation in different dimensions such as communication, coordination and collective problem-solving.

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